Texte

Texte
06
07
ISSN
1862-4804

Safe Construction Products for Health and the Environment:

How much testing is necessary to implement the EC Construction Products Directive?

Umwelt Bundes Amt
Für Mensch und Umwelt

ENVIRONMENTAL RESEARCH OF THE
FEDERAL MINISTRY OF THE ENVIRONMENT,
NATURE CONSERVATION AND NUCLEAR SAFETY

Research Report 202 95 384
UBA-FB 000944

Texte
06
07
ISSN
1862-4804

Safe Construction Products for Health and the Environment:

How much testing is necessary to implement the EC Construction Products Directive?

by

Dipl. Ing. Ulrike Rheinberger
PD Dr. Dirk Bunke

Öko-Institut e.V., Berlin

On behalf of the Federal Environmental Agency

This Publication is only available as Download under
http://www.umweltbundesamt.de

Publisher: Federal Environmental Agency (Umweltbundesamt)
P.O.B. 14 06
06813 Dessau
Tel.: +49-340-2103-0
Telefax: +49-340-2103 2285
Internet: http://www.umweltbundesamt.de

Edited by: Section III 4.1
Outi Ilvonen

Dessau, February 2007

1. Report No. UBA-FB 000944	2.	3.

4. Report Title

Safe Construction Products for Health and the Environment: How much testing is necessary to implement the EC Construction Products Directive?

5. Author(s), Family Name(s), First Name(s)

Rheinberger, Ulrike

Bunke, Dirk

6. Performing Organisation (Name, Address)

Öko-Institut e.V.

Büro Berlin, Novalisstr. 10

D-10115 Berlin

7. Sponsoring Agency (Name, Address)

Umweltbundesamt

Wörlitzer Platz 1

D-06844 Dessau

8. Report Date

March 2006

9. Publication Date

January 2007

10. UFOPLAN-Ref. No.

FKZ 202 95 384

11. No. of Pages: 130

12. No. of References: 90

13. No. of Tables, Diagrams: 16

14. No. of Figures: 8

15. Supplementary Notes: none

16. Abstract

The *European Construction Products Directive* requires that harmonised standards and approvals for construction products fulfil the *Essential Requirement nr. 03 "Hygiene, Health and Environment" of the directive*. The so-called first generation of about 500 product standards and approval guidelines is being published since 2001. With few exceptions, they do not contain any requirements concerning health and the environment. These shall be implemented in the next or second next revisions of the standards in question. To specify the task of implementing requirements, the European Commission has provided a mandate to CEN concerning the standardisation work for the development of horizontal assessment methods relating to dangerous substances under the construction products directive.

To minimise the burden of testing and to avoid that construction products, which have already been demonstrated to be safe for health and the environment, have to be repeatedly tested, the mandate includes the option of exempting groups of construction products by classifying them as WT (accepted without testing) and WFT (accepted without further testing).

The research project had the task to show, how such a classification could be carried out, and which criteria or assessment methods could be applied to product groups to make sure that a high level of health and environment related protection is given. For the purpose, two product groups were chosen as examples: plasters, mortars and gypsum boards for questions related to emissions to indoor air and road construction products for questions related to emissions to soil and groundwater. Representatives of industry, standardisation bodies and public bodies were involved through 6 workshops to gather the state of knowledge and to aim at concepts, which would be supported by the stakeholders.

Assessment methods, criteria and procedural approaches were identified, which allow to classify product groups as safe for human health and the environment from the point of view of German protection levels. It was shown that the chosen product groups could be assumed classifiable as WT, but that in most cases further evidence is required to allow a classification on a scientifically valid basis.

17. Keywords

Construction Products, Dangerous Substances, Indoor Air Quality, Soil and Water Protection, Sustainable Products, Plasters, Mortars, Gypsum boards, Road construction products, Construction products directive, Test methods

1. Berichtsnummer UBA-FB 000944	2.	3.

4. Titel des Berichts

Unbedenkliche Bauprodukte für Umwelt und Gesundheit: Wie viel Prüfaufwand ist notwendig zur Umsetzung der EG-Bauproduktenrichtlinie?

5. Autor(en), Name(n), Vorname(n)

Rheinberger, Ulrike

Bunke, Dirk

6. Durchführende Institution (Name, Anschrift)

Öko-Institut e.V.

Büro Berlin

D-10115 Berlin

7. Fördernde Institution (Name, Anschrift)

Umweltbundesamt

Wörlitzer Platz 1

06844 Dessau

8. Abschlussdatum:
1.3.2006

9. Veröffentlichungsdatum:
Januar 2007

10. UFOPLAN-Nr.:
FKZ 202 95 384

11. Seitenzahl: 130

12. Literaturangaben:
90

13. Tabellen und Diagramme: 16

14. Abbildungen: 8

15. Zusätzliche Angaben: keine

16. Kurzfassung

Die europäische *Bauproduktenrichtlinie* fordert, dass harmonisierte Normen und Zulassungen für Bauprodukte die *Wesentliche Anforderung 03 „Hygiene, Gesundheit und Umweltschutz“* der Richtlinie umsetzen. Die Veröffentlichung der so genannten ersten Generation von etwa 500 Produktnormen und Zulassungsleitlinien erfolgt seit dem Jahr 2001. Von wenigen Ausnahmen abgesehen, enthalten diese noch keine Festlegungen zum Gesundheits- und Umweltschutz. Dies soll in den nächsten und übernächsten Überarbeitungen der Normen erfolgen.

Um die anstehende Aufgabe zu erleichtern, hat die Europäische Kommission das Europäische Komitee für Normung (CEN) mit einem Mandat zur Normung von horizontalen Prüfmethoden für gefährliche Stoffe unter der Bauproduktenrichtlinie beauftragt. Um die Prüflasten zu minimieren und zu vermeiden, dass Bauprodukte, die erwiesenermaßen keine Gefahr für Gesundheit und Umwelt darstellen, laufend geprüft werden müssen, sieht das Mandat die Möglichkeit vor, Produktgruppen von Prüfungen auszunehmen. Solche Produktgruppen könnten eine Einstufung als unbedenklich ohne Prüfung (OP) oder ohne weitere Prüfung (OWP) bekommen.

Im Forschungsprojekt wurde untersucht, wie eine Klassifizierung als unbedenklich erfolgen könnte und welche Kriterien und Bewertungsmethoden für Produktgruppen angewendet werden könnten, um sicherzustellen, dass ein hohes Schutzniveau für Umwelt und Gesundheit gegeben ist. Zu diesem Zweck wurden zwei Produktgruppen als konkrete Beispiele ausgewählt: Putze, Mörtel und Gipsplatten für Fragen zu Emissionen in die Innenraumluft und Straßenbauprodukte für Fragen zu Emissionen in Boden und Grundwasser. Vertreter von Industrie, Normungswesen und Behörden wurden durch sechs Workshops eingebunden, um den Stand des Wissens zu ermitteln und Konzepte vorzuschlagen, die von den Interessenvertretern auch mitgetragen werden können.

Es wurden Bewertungsmethoden, Kriterien und Verfahrensabläufe ermittelt, die es unter Berücksichtigung der deutschen Schutzniveaus ermöglichen, Produktgruppen als unbedenklich für Umwelt und Gesundheit einzustufen. Es wurde gezeigt, dass die ausgewählten Produktgruppen vermutlich als OP klassifizierbar sind, dass aber in den meisten Fällen weitere Nachweise erforderlich sind, um eine Klassifizierung auf einer wissenschaftlich abgesicherten Basis durchzuführen.

17. Schlagwörter

Bauprodukte, gefährliche Substanzen, Innenraumluftqualität, Boden- und Gewässerschutz, Nachhaltige Produkte, Putze, Mörtel, Gipsplatten, Straßenbauprodukte, Bauproduktenrichtlinie, Prüfmethoden

Table of contents

List of Figures

List of Tables

Abstract

In the first generation of harmonised standards and approval guidelines in accordance with the framework of the construction products directive, no requirements were included for the fulfilment of *Essential requirement no. 3 Hygiene, Health and Environment*. These requirements shall be included in the revision of the standards, i.e., in the second generation. For this purpose, the European Commission has provided Mandate M/366 *Horizontal Complement to Mandates CEN/CENELEC, Concerning the Execution of Standardisation Work for the Development of Horizontal Standardised Assessment Methods for Harmonised Approaches Relating to Dangerous Substances Under the Construction Products Directive (CPD)*.

To minimise the burden of testing and to avoid that construction products, which have already been demonstrated to be safe for health and the environment, have to be repeatedly tested, the mandate includes the option of exempting groups of construction products by classifying them as WT (Without Testing) or WFT (Without Further Testing). Formally, WT and WFT are distinguished by the fact that WT classification is based on existing knowledge while WFT classification is based on a characterisation test through harmonised European test methods. The development of testing methods shall begin in 2006. It will take at least 5 years before the first European test methods can be expected.

This report shall contribute to efforts of the European Commission and the European Committee for Standardization to implement the WT-/WFT-Concept. In this project, a national point of view was taken, which means that the question was asked how the WT/WFT concept should be designed to satisfy the existing and targeted level of protection to the environment and health in Germany. The inquiry was carried out on the basis of two exemplary product groups: „plasters, mortars and gypsum boards“ and „road construction products“. In what follows the general results of the project are outlined, before addressing product specific conclusions.

In this project, the question was asked which fundamental characteristics a product group would need to have to be classified as WT or WFT. Different opinions were expressed by the stakeholders involved. On the one hand, the

opinion was held that only products which contain no dangerous substances at all or which contain largely inert materials, as, for example, glass panes could be classified as WT. On the other hand, the opinion was held that product groups could be classified as WT, also when they contain dangerous substances, but do not emit them (or do so in a negligible way). In the latter case, the complexity of the chemical composition is not the critical factor, but the completeness and reliability of existing knowledge of the products.

In conclusion, we argue for the possibility of defining the WT classification in a wider rather than more restricted sense. For two reasons: firstly, it is the objective of WT or WFT classification to minimise testing burden where it is not essential for the protection of health and the environment. WFT classification is more onerous with regard to administrative and technical realisation than the WT one, due to the necessary characterisation test based on harmonised test methods. As far as the objective – i.e., the identification of construction product groups that are safe for health and the environment – can be achieved with the less onerous procedure, this should be made possible. Secondly, it should be avoided that construction product groups which have already been extensively investigated are tested again only for formal reasons, if the results are already predictable. In the end, this would also reward those manufacturers who have already invested in testing and optimizing their products with regard to health and environment related performance.

The next decisive question was, which benchmark and which procedure would be appropriate to achieve the WT or WFT classification. The WFT classification will be possible only once the corresponding European test methods are available. For this reason, the focus of the project was put on the question if and how a WT classification could be managed.

Construction products have to be safe for health and the environment – no matter whether they are classified as WT or WFT or if they have to be continuously tested. The reference points are the National and European Legal Provisions. Environmental and health related target values (immission values) are set either on European or on national levels. However, the transfer to corresponding product related test and limit values (emission values) is partially still under development. Product related tests and the definition of product related test values are also always a convention-based compromise between precise reproduction

of actually occurring contributions to immissions and feasibility and testing efforts.

In Germany, for indoor air quality as well as for effects on soil and water, assessment methods are available, which prescribe which emission-related criteria construction products have to fulfil to be in accordance with immission related provisions and target values. The scheme of the *Committee for Health Assessment of Construction Products* (German designation: *Ausschuss zur gesundheitlichen Bewertung von Bauprodukten – AgBB*) describes the *Procedure for the Health Assessment of Emissions of Volatile Organic Compounds (VOC und SVOC) from Construction Products*. The principles of the *German Institute for Structural Engineering (*German designation*: DIBt - Deutsches Institut for Bautechnik - DIBt)* describe the *Assessment of Effects of Construction Products on Soil and Groundwater* ".

With these, at least from a national standpoint, benchmarks are available for the assessment of "safe for health and the environment" for WT and WFT as well as for FT classification. They represent the starting point and the criteria for the development of horizontal European testing methods, but they offer already today an orientation for WT classification. This does not mean that construction product groups have to be tested in all cases according to the test methods mentioned in the assessment methods, but rather that the criteria mentioned there represent the benchmark for such classification. For some product groups testing might not be necessary, when it is clear from a scientifically based documentation that the products fulfil the criteria of the assessment methods. For other product groups, test results corresponding to the criteria mentioned in the assessment methods might be necessary to ascertain safety for health and the environment beyond any doubt.

From a national point of view product groups, which fulfil the above-mentioned assessment methods, can be assessed as WT, as long as other existing specific provisions are eventually fulfilled, as for example those for formaldehyde. The prerequisite being that the product group is homogenous and stable with regard to release characteristics and that fulfilment of the criteria, with respect to compliance with target values, has been clearly proved. However, it has to be clarified if other Member States have additional or stricter requirements, as WT or WFT classification requires that a product group fulfils all the requirements applied in the Member States. This was not assessed in the current project.

ABSTRACT

Harmonised European standards and approval guidelines are and should be formulated “performance oriented”. For the definition of mechanical characteristics, this can be usually achieved without defining the product’s material composition. With regard to health and environmental characteristics, the performance (i.e., the release of dangerous substances) depends on the chemical composition, (i.e., the substances contained and their chemical bond). For products continuously tested for their emission performance, a substance-based product definition is not essential. However, for WT classification it is obligatory to define product groups so clearly that all product variants on the market are covered. This may be unproblematic for some product groups, as, for example, glass panes. For other product groups, in particular for formulation-based products, it would be target-oriented to include substance-related product definitions or certain descriptive attributes in the standards.

For WT classification - to put it simply - three conditions have to be fulfilled. There is a generally acknowledged assessment method, which can be used as a benchmark for the assessment of health and environmental safety. It is possible to formulate a product definition that clearly describes products with regard to their health and environmental performance. Applicants are able to present generally acknowledged and scientifically based documentation and/or research or testing results for their product group.

In comparison to other essential requirements, which have to be fulfilled within the construction products directive, there is less experience for the assessment of health and environmental-related product performance. Therefore for WT classification an expert group, which will assess requests for WT classification, will have a key role. While it is conceivable that in the future self-classifications may also become an option, in the beginning it is indispensable that questions and doubts that arise will be evaluated by a body that has an accordingly broad competence and authority.

In the project, exemplary product groups provide concrete examples of problems that arise when classifying a product group as WT and how they might be solved. For indoor air related questions, the groups of plastering, mortars and gypsum boards have been chosen. These product groups were assumed, on the one hand, to be safe with regard to indoor air, while, on the other hand, they presented a challenge, because of the great number of formulations to be assessed. With regard to soil and groundwater, road construction products were

chosen, because the product groups were assumed safe and because the body of regulation for road construction has a longer tradition of integrating environmental requirements.

For plasters, mortars and gypsum boards the project confirmed this assumption and the workshops carried out with representatives of public authorities and industry confirmed that these product groups are generally safe for indoor air emissions and that they are suitable for WT classification. One can expect that no significant indoor air emissions occur with the substances usually used for the composition of these products. However, it also became evident that for the formulation of a scientifically validated documentation, some basic research on emission performance is necessary to prove safety. In addition, solutions have to be found to provide unambiguous product definitions. The *Industry Association of Factory-Made Mortars* (*Industrieverband Werkmörtel*) has commissioned in the meantime a research project on the products produced by its members, where tests on the emission and release performance of different product types will be carried out to provide the scientific basis for the request of WT classification.

In the road construction products group, asphalt, concrete and aggregates were considered. As a result, it was found out that asphalt and concrete products for road construction may be classified as WT with a relatively simple documentation. As they are applied as water impermeable constructions, no seepage water can contribute to hazards for soil and groundwater. While being product groups with partially complex compositions also containing dangerous substances, (for example, additives), the intended use ensures safety for health and the environment. A further condition for the classification of asphalt and concrete in road construction is that requirements concerning secondary construction materials applied in Germany are also considered.

The result for natural aggregates was a surprise, as at the beginning of the project it was assumed that this product group could also be classified as WT with a simple scientifically based documentation. As long as the intended use is to apply them in impermeable construction methods, the WT classification can result from the same documentation as for asphalt and concrete. If the intended use is for water permeable construction methods, one must ask if dangerous substances could be released, which reach soil and groundwater through the seepage water. This question does not arise, when natural aggregates are used

in the geological regions where they have been extracted. Here no deterioration of geogenic background concentrations is to be expected. When using them in other geologic regions in water permeable construction methods, it cannot be excluded that aggregates with higher contents of trace-elements release substances in concentrations above precautionary values defined within the framework of soil protection and water management regulations.

For natural aggregates applies analogically to plasters, mortars and gypsum boards: for the formulation of a request for WT classification, a reliable standard of knowledge has to be proved. For this, results from orienting leaching tests for aggregates with high contents of trace elements could be sufficient. As natural aggregates become better described in the context of extraction applications, such orienting test results could well be transferred to the entirety of aggregates. Another option would be to approve WT classification with the proviso that it is only valid for water permeable construction methods, if the construction is carried out in the geological region of the extraction site (or in an equivalent or less sensitive region).

1 Introduction

Construction and housing in the member states of the European Union has grown out of different traditions, with the consequence that products and construction methods may vary considerably, as well as national technical and legal rules. Increasing internationalisation of markets and the claim of „the realisation of a European common market“, made in the *Single European Act* have led to more and more national technical rules being harmonised in terms of EN or ISO standards. The *Construction Products Directive 89/106/EEC (CPD)* creates a legal obligation to develop European standards and approval guidelines for construction products and to introduce them in a binding way to dismantle trade barriers.

The Council of European Manufacturers of Construction Materials estimates that in Europe about 20.000 different construction products are on the market [CEPMC 2005]. Characteristics and performances, which these construction products should have in order to be fit for use and to fulfil the requirements of the construction products directive, are specified in standards and approval guidelines.

In practice the implementation of the CPD has taken a long time and been difficult. The first so-called harmonised standard, the cement standard EN 197-1 [CEN 2004], was only published in the Official Journal of the European Communities in 2001, 12 years after the directive came into force. By mid 2005, about 200 standards have been harmonised. However, this was only possible because these standards – the so-called first generation - did not implement all of the six *Essential Requirements*, according to the mandate of the directive. Apart from a few exceptions, the *Essential Requirement - Hygiene, Health and Environment* has only been fulfilled *pro forma* by introducing a general reference recalling that national health and environmental regulations have to be observed.

In the light of this situation, the *Federal Environmental Agency (German designation: UBA - Umweltbundesamt)*, supporting in Germany the establishment of health and environment related requirements in standards and approval guidelines, has commissioned the Öko-Institut to develop proposals about how such requirements could be implemented in the next generation of harmonised construction product standards.

1.1 Assignment

The CPD provides that requirements for construction products have to be harmonised with European standards and approval guidelines. This applies in particular to test methods; however, different levels of requirements are still admissible. Through mandates, the European Commission assigns the *European Committee for Standardization (CEN)* and the *European Organisation for Technical Approvals (EOTA)* to revise or develop European standards and approval guidelines for the different product groups. By means of requirements in the mandates, the European Commission can verify and ensure the quality of the results.

The implementation of health and environmental related requirements has been particularly intricate. This is because it generally requires long negotiations in the CEN working groups to bring the different national and economic interests into consensus. Furthermore, in the CEN working groups and the national shadow working groups involved in the harmonisation of construction products, only few health and environment

experts were present. Standards and approvals shall not define original health and environmental related requirements, but only convert what has been laid down in European or national provisions in feasible product related tests, values and marking provisions. However, health and environmental related requirements (and perception) differ widely in the member states or are still under development.

The solution as to how health and environment related requirements may be implemented in the second and third generation of standards and approval guidelines still lies ahead. Overall, there are about 700 product and test standards to be harmonised under the framework of the CPD. Given this number, it seemed reasonable to concentrate on a couple of product groups in the project. The basic idea was to start with products that promised simple solutions, and to provide evidence that health and environmental related requirements could be implemented in a way satisfactory to all interested parties.

At the beginning of the project, the suggestion (coming from both the manufacturers and the authorities) was taken hold of that the majority of the construction products could be classified as safe with regard to health and the environment. Identification of generally safe product groups (originally referred to by the catchword „approved materials“) had the purpose of limiting and facilitating the task of implementing the *Essential Requirement – Hygiene, Health and Environment*. From the first discussions, however, it became evident that the difficulty of this approach (otherwise plausible and desirable for all interested parties) is in the details: which delimitations are necessary? Which criteria are applicable? What evidence is acceptable? How can such classification be carried out formally? What revisions are to be required?

During the course of the project the approach has been scrutinised by the European Commission and incorporated under the title *Concept of products and Materials „Without Testing (WT)" and „Without Further Testing (WFT)"* into the mandate M/366 "*Horizontal Complement to the Mandates to CEN/CENELEC Concerning the Execution of Standardisation Work for the Development of Horizontal Standardised Assessment Methods for Harmonised Approaches Relating to Dangerous Substances Under the Construction Products Directive (CPD)"* [EC 2006b].

1.2 Objective

The objective of the project was to show by means of exemplary product groups if and how it could be possible to classify standardised groups of construction products as categorically safe. The objective was also to show which difficulties arise and how they could be solved. The chosen product groups should address questions related to health related emissions to indoor air and release to soil and groundwater as well as have an economic relevance to the German construction products industry.

On the one hand, by means of the chosen product groups it should be made clear in detail how delimitations could be made between:

- Products without testing (WT),
- Products without further testing (WFT) and
- Products for further testing (FT).

On the other hand, the possibility of a generally valid approach should be deduced.

The results and the report should be made available to CEN TC 351 *Construction Products: Assessment of Release of Dangerous Substances,* which was founded for implementing mandate M/366. In particular, the purpose is to facilitate the development of *Technical Report 3*, dealing with the classification of safe product groups. Furthermore, the project should also lay out grounds for the tasks of the expert group of the European Commission *Dangerous Substances in the Field of Construction Products*.

In addition, it was critical from the start that the proposals should be acceptable to not only the authorities in charge of structural engineering, road construction and health and the environment, but as well to the manufacturers of construction products. The latter ones carry out most the standardisation tasks in the working groups of the *German Institute for Standardisation (DIN)* and CEN and the so-created general framework determines the market and the market conditions.

1.3 Approach

1.3.1 Identification of exemplary product groups

As a first step, two product groups were to be identified, which could show in an exemplary way if and how a WT/WFT classification would be possible and feasible. The chosen product groups had to fulfil the following criteria:

- One product group should be used for the construction of components in contact with soil and/or groundwater, to discuss questions of hazards to soil and groundwater.
- The other product group should be used indoor on large surfaces to pose questions in relation to emissions of volatile organic compounds to indoor air.
- The product groups should – at least to a large extent – be covered by mandates of the CPD.
- The product groups should have significant production volumes and be of interest for German manufacturers.
- The product groups should include products that are in advance supposed to be suitable for WT/WFT classification. Ideally, products that seem unsuitable should also be included to highlight delimitation issues.
- From the side of the manufacturers there should be an interest in participating in workshops and discussions on WT/WFT classification.
- Product groups that already been intensively discussed with regard to health and the environment in working groups set up by authorities should be excluded.

In consultation with the contractor and after preliminary discussions with representatives of manufacturers with regard to soil and groundwater, the group of road construction products was chosen. They seemed to be of interest insofar as this group of products has a longer tradition with regard to the implementation of health and environment related requirements. With regard to emissions to indoor air, the product group of plasters, mortars and gypsum boards was chosen. On the one hand, it was assumed that the predominantly mineral product group could be assessed as categorically safe. On the other hand, the varying formulations of the products were expected to be an important issue with regard to classification.

1.3.2 State of Knowledge

To start the work on the product groups (i.e. *road construction products* and *plasters, mortars and gypsum products*) the following relevant basic information was collected:

- Produced and/or used amounts
- Mandates of the CPD, which cover the chosen product groups and their requirements
- Summary of the standards and technical rules and their state of elaboration.
- Directly or indirectly health and environment related laws, regulations and administrative provisions relevant to the chosen product groups. Considered were German and European regulations.
- Available research results and information concerning composition, content of dangerous substances and release characteristics.
- State of mandate M/366

1.3.3 Workshops and Exchange with Interested Parties

Knowledge was to be gathered in the broadest possible way and the interests of most of the stakeholders concerned were to be considered. Therefore a number of workshops were conducted, discussing, on the one hand, abstract ideas for the design of the classification of WT/WFT products and, on the other hand, elaborating the current state of knowledge concerning potentially critical substances and their emission characteristics.

Representatives were involved from the *German Institute for Structural Engineering (DIBt)*, the *Federal Environmental Agency (UBA)*, *Working Groups of the German Länder on Waste Issues, Water Issues and Soil Issues (LAGA, LAWA, LABO)*, *the Federal Highway Research Institute (BASt)*, the *Committee for the Health Assessment of Construction Products (AgBB)*, industry associations as well as enterprises involved in the standardisation process (see Appendix A).

Three workshops on road construction products were conducted, as well as two workshops on plasters, mortars and gypsum boards. Furthermore, a number of individual discussions were held with representatives of authorities and industry.

1.3.4 Report

The results of the research, the workshops and the discussions with representatives of authorities and industry are outlined in the present report. The contractor shall receive an overview of relevant products and their use, as well as an overview of the structure of the body of rules and regulations. Furthermore, the results of the workshops and proposals that have being deduced from them, concerning the classification of WT/WFT products as well as the adaptation or revision of corresponding standards is presented.

The draft of the final report was presented to the parties involved during a final expert discussion, which gave everyone the possibility of commenting on relevant points from their respective point of view. The hope was to arrive together at conclusions based on a broad consensus.

2 The Concepts „Without Testing" (WT) and "Without Further Testing" (WFT)

2.1 Background

2.1.1 Mandate M/366: Development of Horizontal Standardised Assessment Methods"

The so-called first generation[1] of standards and approval guidelines, harmonised under the framework of the CPD, was published, even though in the majority of cases no requirements concerning hygiene, health and environment were put forward. The essential requirement of the CPD *Hygiene, Health and Environment* was only formally fulfilled by introducing a standard clause in Annex ZA of the standards and approval guidelines. This clause points out in general form that – beyond the requirements of the standards and approvals – existing European and national requirements with regard to dangerous substances have to be fulfilled.

To concretise the assignment to CEN and EOTA for the accomplishment of the *Essential Requirement - Hygiene, Health and Environment* the European Commission issued an additional mandate. "The *Horizontal Complement to the Mandates to CEN/CENELEC Concerning the Execution of Standardisation Work for the Development of Horizontal Standardised Assessment Methods for Harmonised Approaches Relating to Dangerous Substances Under the Construction Products Directive (CPD)*" [EC 2006b] (in the following denominated mandate M/366) was published in April 2005 after consultation with the *Standing Committee for Construction* and with the *Committee for Standards and Technical Rules* (Committee 98/34).

Mandate M/366 assigns the development of harmonised European measurement and test standards to CEN. The test standards shall allow requirements concerning hygiene, health and the environment in the harmonised product standards and European technical approvals to be aligned. They shall as far as possible adapt to the already existing harmonised standards or to those currently under development. In terms of the CPD, the measurement and testing standards to be harmonised are limited to those dangerous substances, which may be released in the use phase. As far as practicable, the so-called performance principle has to be applied, which means that measurement and testing standards shall cover emissions of dangerous substances from construction products.

The technical specifications of mandate M/366 include a concept for products and materials „Without Testing" (WT) and „Without Further Testing" (WFT). This concept is based on the assumption that it should be possible to demonstrate, for a large number of products, that they are harmless for human health and the environment. That is to say, they do not contain any dangerous substances or do not have the ability to release

[1] Standards of the first generation are considered as the first harmonised versions of standards that were developed and mandated by the CPD. Following the first revision of the standards, (as a general rule after five years), a second generation of standards will emerge.The first standards of the second generation are expected for 2006. Correspondingly, the terms first and second generation apply to approval guidelines.

dangerous substances into the soil, ground or surface water, or the indoor air, in quantities above the limits regulated in any Member State of the EU. Therefore such products do not require further testing (according to the elements of control of conformity as defined in Annex III of the CPD). For Germany, however, in consideration of the assessment methods applied to construction products for the purpose of assuring that existing regulations are fulfilled and safety is verified, it is not decisive if single substances are regulated or not, but only if the entirety of substances used and emitted do not cause any hazards[2].

The concept WFT aims at providing characterisation data with harmonised European test standards, verifying that construction products meet European or national requirements with regard to relevant dangerous substances. Mandate M/366 envisages that the European Commission could establish a list of WT and WFT products after consulting the *Expert Group "Dangerous Substances in the field of Construction Products*" and after approval by the *Standing Committee of Construction*. The purpose of this approach is to reduce the burden of testing with regard to hygiene, health and the environment, similar to the way this is handled in the context of the *Essential Requirement - Safety in case of fire* with the CWFT approach (Classified Without Further Testing).

However, mandate M/366 includes no concrete directions as to how the classification of WT or WFT product groups could be implemented. At the time of the draft of the present report, the European Commission was working on the details concerning procedural aspects of WT and WFT classification. Starting in April 2006, the newly founded TC 351 *Construction Products: Assessment of Release of Dangerous Substances* will start drafting the technical report on the WT and WFT concept as foreseen by mandate M/366.

2.1.2 The CWFT Example for the Implementation of the *Essential Requirement Safety in Case of Fire*

Harmonised standards have the purpose of defining requirements with regard to fire performance of construction products. To avoid that construction products, whose fire performance is known and stable because of their material characteristics, have to be continuously tested, the option of CWFT classification (Classified without further testing) was introduced. That the efforts required for extensive product tests can be considerable, is shown by a study carried out in Great Britain on the effects of the new European classification for the reaction to fire performance to the construction material industry. For England and Wales, the additional costs to the manufacturers of construction products because of the new harmonised fire performance tests were estimated at about 4 Million pounds. [ODPM OFFICE OF THE DEPUTY PRIME MINISTER 2005].

The European Commission has therefore created the CWFT option, which allows for omission of tests. *„The reaction-to-fire performance of many construction products and/or materials, within the classification provided for in Decision 2000/147/EC, is well*

---

[2] See Model Building Code (Musterbauordnung), section 3: "Works shall be arranged, erected, modified and maintained in such a way that public safety and order, in particular human life, health and natural resources, are not endangered." Similar provisions are also included in the building regulations of other EU countries. See for instance the Building Regulations of Scotland, section 3: "Every building must be designed and constructed in such a way that there will not be a danger to the building nor a threat to the health of people in and around the building due to the presence of harmful or dangerous substances."

established and sufficiently well known to fire regulators in Member States that they do not require testing for this particular performance characteristic " [EC 2006a].

CWFT products have been proven to be stable in a given European class (on the basis of testing in accordance with the appropriate EN test method(s)) within the scope of their variability in manufacture allowed by a product specification (harmonised standard or ETA). In addition, CWFT products have been evaluated to be stable regarding the influence of other possible variations occurring outside the scope of specification, which could have an impact on their fire performance. " [ÖSTMANN 2006].

The CWFT concept has been implemented by establishing a list of CWFT products. The list contains products in the sense of generic products, but not single products or brands (i.e., proprietary products). Considered as products are product families, sub-families and product groups as defined in Guidance Paper G [EC 2003].

Product Family): Refers to a set of generic products having a similar intended use (e.g. internal wall finishes, roof coverings).

Product Sub-Family: Refers to a subset of a product family, grouping together products having a similar nature (e.g. wall panels, flat and profiled roof sheets) or behaviour (e.g. products that melt or shrink under flame attack).

(Generic Product): Refers to a set of products, grouping together the whole European market (e.g. plasterboard, fibre cement sheets).

(Product): Refers to a construction product, as defined by the CPD, from an individual manufacturer (i.e. the item to which the CE marking applies). According to the CPD, 'construction product' means any product which is produced for incorporation in a permanent manner in construction works, including both buildings and civil engineering works [EG 1989].

Prerequisites for the request for admission to the CWFT-list are:

1. The fire performance of the product is demonstrated by testing to be stable.
2. Tests have shown that the products satisfy a given Euroclass.
3. The products have been defined with sufficient precision.
4. In a two-stage procedure interested parties can make a request for admission to the CWFT-list. In the first stage, a given product is approved to be suitable to be put on the CWFT-list. In the second stage, there is a detailed analysis of the case. The application must include a detailed product definition, the intended uses, the class in which the product is considered stable, and the permissible / likely variations in the product during manufacture as well as results from national and European tests. With regard to intended uses and variations during manufacture, a number of parameters are given.

The European Commission publishes the CWFT-list after approval by the *Standing Committee of Construction* as a Commission Decision. The *Expert Group on Fire Related Issues* (EGF) assesses single requests of admission to the list and prepares recommendations for consultation in the *Standing Committee of Construction*. The EGF is supported by a *CWFT Working Group*. The *CWFT Working Group* includes representatives of authorities, of the CEPMC (Council of European Manufacturers of Materials for

Construction), of the Notified Bodies Group, of CEN/TC 127 (Technical Committee for Fire Safety in Buildings, WG4) and EOTA.

Proprietary products are considered CWFT, if they correspond to the product definition agreed in the CWFT procedure, i.e. virtually to the product definition of the corresponding standards or approval guidelines. The manufacturers of a proprietary product decide by themselves, if a product corresponds to the standards given in the CWFT list and to the respective decision of the European Commission. Prerequisites are that the proprietary product corresponds to the criteria in the CWFT list and with regard to fire performance to the class assigned in the list. If a manufacturer wrongly applies the CE-marking, the safeguard clauses of the CPD apply. The manufacturer is always responsible for the compliance of his products with the definitions and specifications.

2.1.3 The WT/WFT Concept

A substantial difference of the WT/WFT concept in comparison to the CWFT concept is that in the context of implementation of the *Essential Requirement - Hygiene, Health and Environment* no harmonised European classes exist, as is it the case with regard to fire performance. The TCs may define technical classes for different intended uses. Different levels of protection based on national regulations in the member states would have to be defined by the introduction of regulatory classes, which have to be established by a Decision of the European Commission. Therefore, the actually defined technical emission classes for formaldehyde introduced in EN 13986 – Wood Based Panels and certain other hEN would have to be replaced by European regulatory classes.

In principle, it is conceivable that in the future regulated European classes will also be defined for health and environment related issues. In the project workshops, the participants suggested that for the classification of WT or WFT different emission classes could also be defined to reflect the different levels of protection in the Member States or to allow for different intended uses, as, for example, the use of construction products in rooms permanently occupied as opposed to those not permanently occupied. For actual implementation, the assumption in this project is that there will be only one common WT respectively WFT classification.

At the time of the drafting of the report, there were no procedural or factual definitions as how the WT or WFT classification would be carried out in detail. It was, however, assumed that the following differentiation between WT and WFT classifications could be regarded as a stable basis for further considerations.

Definition WT/WFT Products

Without testing (WT) refers to products, which are well established and sufficiently well known to regulators in Member States (based on generally accepted knowledge, testing and/or existing data) with the consequence that they do not require any testing according to a harmonised test standard.

Without further testing (WFT) refers to products, for which it has been proven to regulators in Member States (based on testing with the appropriate EN test method(s)) that they do not require further testing according to harmonised test standards.

For the classification as WT as well as for WFT it has to be proven that product groups in their entirety do not cause any hazard to hygiene, health and the environment by the emission of dangerous substances. In the case of WFT, this demonstration is based on European harmonised test standards as they will be developed based on mandate M/366. The WT classification may be based on the generally recognised state of knowledge as well as on results from tests, which do not necessarily have to be carried out according to harmonised European test standards. What evidence is required for the single product groups ultimately depends on the chemical composition of the used materials and the intended use and varies from case to case.

In a way that is comparable to the committees and working groups entrusted with the assessment of applications for CWFT classification, it is envisaged that the expert group *Dangerous Substances in the Field of Construction Products* will assist the European Commission in assessing applications for WT/WFT classification. The expert group could be supported by a WT/WFT working group. The classification of the product groups and the draft of WT/WFT lists would be consulted in the *Standing Committee on Construction* and published as a Decision of the European Commission.

Proposals to simplify the procedure aim at leaving the decision for WT/WFT classification to notified bodies or by letting the manufacturers themselves decide. Classification by notified bodies creates the problem of a conflict of interest: these bodies should decide on the necessity of testing, while having an intrinsic interest in testing assignments. Classification by manufacturers themselves has the problem that no long-term experience and no European-wide benchmarks are available in the field of health and environmental related requirements for construction products, which would allow for the assessment of the very different product groups. It is therefore a recommendation of this report that a competent expert group approves the classification.

Analogous to the CWFT classification requirement that construction products have to be stable within the scope of variability allowed by the product definition, products have to be homogenous with regard to emission characteristics. While in relation to fire performance, characteristics such as density, geometry and end-use parameters as mounting method and exposure [EC 2004] are of particular relevance; in relation to health and the environment, chemical characteristics are of particular relevance. These are determined firstly by the chemical composition of the products, insofar as potentially dangerous substances are used or present in the source materials. Secondly the chemical bonds of the substances contained are relevant. Moreover, the intended use and the construction method are also of interest.

The experience and the formal procedure of the CWFT concept may in principle be used and adopted for the WT/WFT concept, but it is essential that for the WT/WFT concept assessment methods and technical criteria for the classification are defined. This represents a bigger challenge than is the case of fire performance, because Member States do have less experience with the implementation of health and environment related requirements than they do for the implementation of fire performance related requirements.

2.1.4 Dangerous Substances

Mandate M/366 expresses the definition of the substances to be comprised as follows: "*The mandate deals with the subject of emission of dangerous substances from con-*

struction products as defined in the CPD that may have harmful impacts on human health and the environment as called for under the Essential Requirements 3 of the CPD, hereafter referred to as ER3. The scope of this mandate covers these substances as far as they are relevant with regard to construction products and, due to the risk of harmful impacts, are restricted or banned by any EU and/or Member States notified regulations, hereafter referred to as "regulated dangerous substances". [EC 2006b].

The CPD does not explicitly define dangerous substances, but refers on the one hand to the giving-off of toxic gases, the presence of dangerous particles or gases in the air, the emission of dangerous radiation and on the other hand to the prevention of pollution or poisoning of the water or soil. The interpretative document Nr. 3 and the guidance paper H also remain rather vague as to what is understood by dangerous substances. A look at the respective regulations shows that the terminology is not consistent. In German regulations the term „*gefährliche Stoffe*" and „*Gefahrstoffe*" as well as „*Schadstoffe*" is used, in English the term „dangerous substances" as well as „hazardous substances" is used without providing any information as to what the differences between the definitions would be. In Appendix B definitions of pertinent regulations are given. A substance is dangerous or hazardous when it can have undesired effects on human health or the environment. This includes both substances, which according to the European Classification and Labelling Directive are defined as dangerous[3], and substances, which are not classified as dangerous in the sense of the Directive, but pose a hazard when released[4].

The essence of mandate M/366 is that only those dangerous substances are to be included which are covered by regulations notified according to the Information Directive 98/34/EC or by European regulations. This is reasonable and coherent insofar as otherwise standard organisations would be implicitly assigned to introduce health and environmental related regulations. Apart from juridical reasons, it is not in the interest of health and environmental protection to shift the authority of regulation making to the standardisation bodies, whose core competence lies in the field of technical requirements for construction products.

Indeed this pre-definition – even if coherent at the first sight – does have some shortcomings for two reasons:

- Standards are an instrument of voluntary self-regulation. Beyond market competition technical committees agree not only on minimal requirements, but also on product quality and reliability of product groups. For example, authorities have not solely developed many requirements and test methods in relation to mechanical stability. Manufacturers have co-developed the requirements and laid them down in standards, which in their turn are referred to in regulations. With the narrow specification expressed in the mandate, Member States are virtually invited to regulate any question of product related health and environmental protection via introduction of notified regulations. This means giving away the potential of standardisation to achieve good solutions by voluntary

[3] Directive 67/548/EWG names as danger categories: explosive, oxidising, extremely flammable, highly flammable, flammable, very toxic, toxic, harmful, corrosive, irritant, sensitising, carcinogenic, mutagenic, toxic for reproduction, dangerous for the environment.

[4] An example of one such substance is sulfate. Sulfate is not classified as dangerous, but can have hazardous effects on soil and groundwater if released in excess.

self-commitment and to contribute to politically wanted deregulation.
➔ The voluntary establishment of health and environmental related requirements in product standards, which exceeds existing regulations, presents a contribution to technical progress and to deregulation.

- It is rational and feasible that test methods, which relate to regulated dangerous substances are harmonised with priority. With regard to the classification of products as WT, it is problematic to refer only to notified regulations: first of all, there are knowledge gaps with regard to material properties of many substances or at least the systematic classification of properties is missing. These gaps will be systematically closed only in the course of the implementation of REACH[5]. Secondly, in the field of soil and groundwater as well as in the field of indoor air, product related concepts and rules, which transfer the requirements of health and environmental related protection to product related requirements, are yet under development. In Germany, applied assessment methods for construction products, which implement effective legislation, assume that construction products are safe, when released substances do not cause any hazard, independently of the single substance being regulated or not[6]. The reference only to notified regulation would mean to be oriented on a partially overcome state of knowledge. This would risk discrediting WT classification and ultimately also the reliability of CE marking.
  ➔ Well-founded classifications of WT products should consider beyond notified regulations also the current state of knowledge and precaution.

The challenge ultimately is that there are health-related and environmental regulations on the immission side, which are widely notified, but the practical transfer to product related emission and test values is yet to be implemented. This is exactly the task assigned by mandate M/366.

2.2 Implementation of the WT/WFT Concept for Construction Products

2.2.1 Premises of the Project

At the start of the project in 2003 the development of mandate M/366 had only just begun. Therefore, it was not possible to refer to an existing concept; rather certain premises had to be defined in order for the project to proceed. This had the advantage of allowing to be less guided by formal provisions, and instead to be oriented solely to functional questions, i.e., which products from a national view could be classified as generally safe.

The points of departure were:

- Construction product requirements are deduced from the national building law, as well as from national and European health and environment related legislation.

[5] REACH: **R**egistration, **E**valuation, **A**uthorisation of **Ch**emicals

[6] The Principles for *Assessment of the effects of construction products on soil and groundwater* prescribe biological tests for the leachate of construction products. The produced leachate has to be harmless in its entirety.

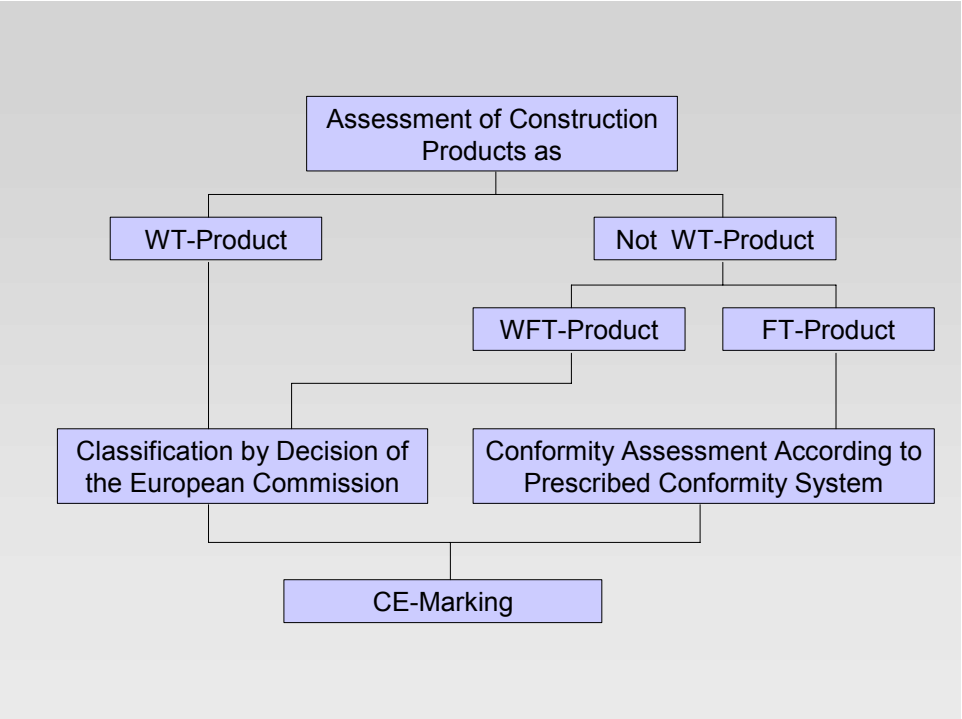
- In Germany, over the last few years the integration of health and environment related specifications has begun in standards and approvals of construction products and structural engineering. In this connexion, the implementation of health and environment related requirements in technical approvals is trend setting with regard to performance orientation. Now this also has to be implemented for standardised construction products, which on a quantitative basis represent the larger part of the applied products. The technical rules with regard to road construction present a particularity. For many years, environmental related requirements with regard to the use of secondary construction materials have been systematically integrated.
- The transfer of the immission related target values into product related test values partially is still under development, in particular in the field of soil and groundwater. In the field of indoor air, there are only singular legally binding limit values. Values are given, which *per se* are not legally binding and are referred to only in the context of the substantiation of generally kept health related objectives; for example, when they are taken into consideration for the implementation of § 3 of the *Model Building Code (German designation: MBO – Musterbauordnung*) [ARGEBAU 2002] to work out approval principles for products.
- In addition, general knowledge gaps exist with regard to toxic and environmental effects of substances. Only part of the substances used in Europe have been subjected to a „risk assessment“, and only about 4.000 substances are listed in Annex I of Directive 67/548/EEC. There are no research results or estimates available as to which substances - and in which amounts - are used for the production of construction products, which are insufficiently assessed and classified. These knowledge gaps will presumably be closed only when a comprehensive classification of all substances will be carried out in the context of REACH.

Therefore, we took the following working hypotheses were taken as starting points:

- Only regulations in force and the level of protection aimed at in Germany was taken into account.
- Only standardised products are considered.
- The focus is on technical and scientific aspects rather than on juridical details.
- The focus is put on product groups classifiable as WT or WFT in their entirety. This does not mean that products from product groups, which at the present state of knowledge are not classifiable as WT, would not be fit for use. It means only that they either have to be subject to a characterisation test to be classified as WFT, or continuously tested to allow for CE-marking.

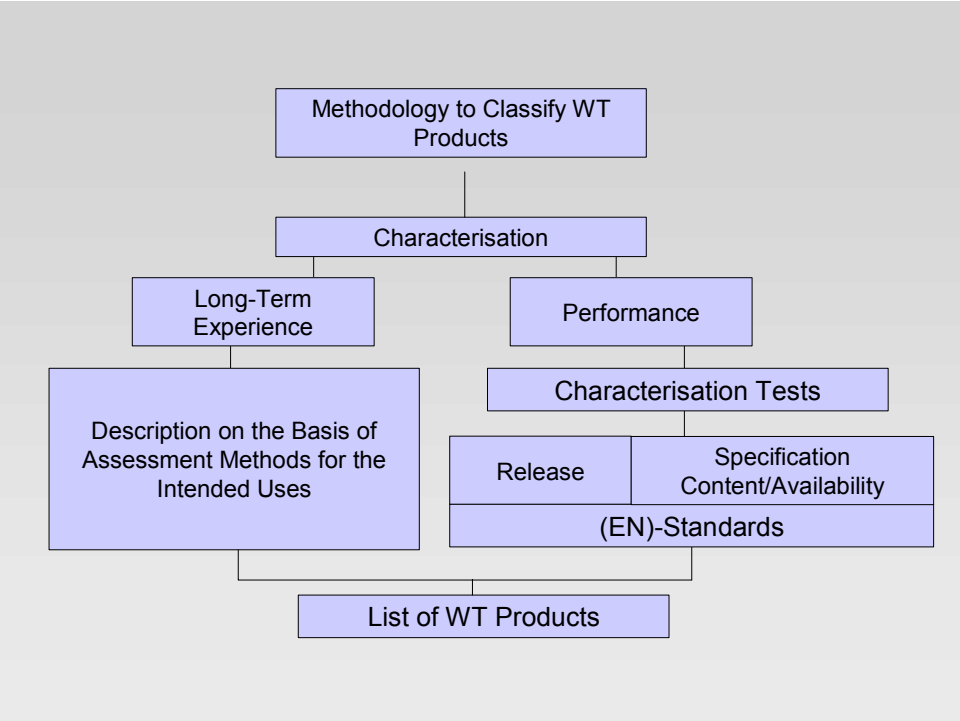
The following figure shows the envisaged procedure.

Figure 1 – Procedure to CE-Marking for WT, WFT, FT products



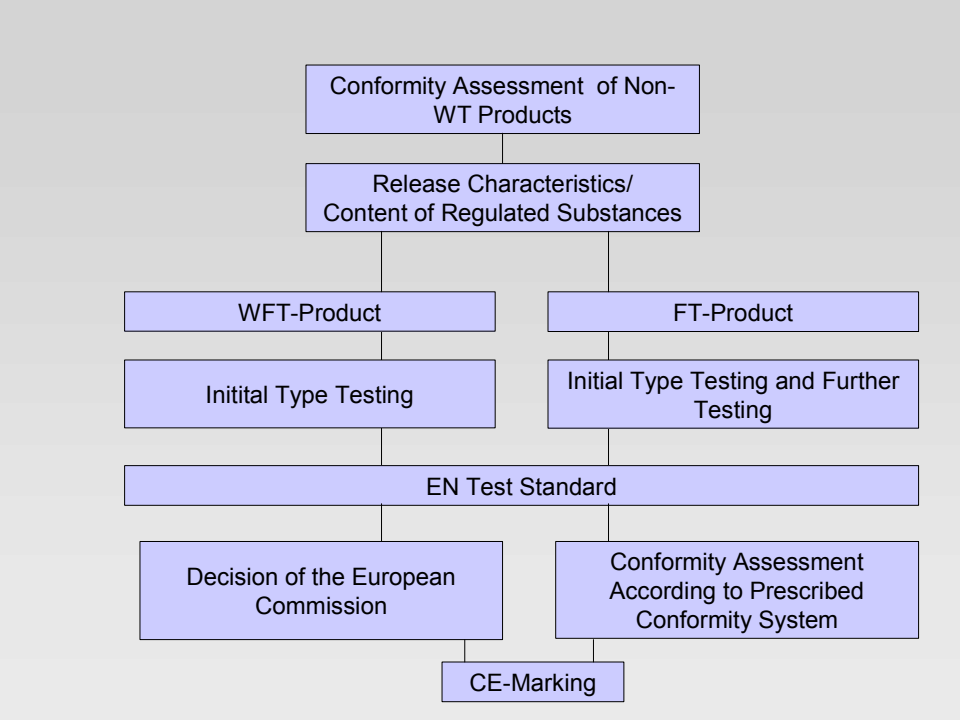
Source: Adopted after [DIJKSTRA 2005]

Figure 2– Classification of WT-Products



Source: Adapted after [DIJKSTRA 2005]

Figure 3– Classification of Non-WT-Products



Source: Adapted after [DIJKSTRA 2005]

2.2.2 Benchmarks for the Classification of Products as WT/WFT

In the workshops, the following principles for the classification as WT and WFT were discussed and developed.

- Construction products can be classified as WT or WFT, if hazards to humans and to the environment can be excluded in principle in the sense of § 3[7] of the *Model Building Code* (German designation: MBO) [ARGEBAU 2002] and the § 3[8] of the *Federal Highway Act*[9] (German designation: FStrG).
- **Hazards are excluded** if no or negligible emissions and effects occur during the use phase by dangerous substances or ionising radiation.
- **Dangerous substances** to be considered, when assessing products**:**[10] Substances or substance groups classified as dangerous to health or to the environment (according to the criteria in Annex VI of Directive 67/548/EEC, labelling by an R-phrase) as well as substances which may have negative effects on health or the environment (e.g. due to pH value, electrical conductivity, odour, creation of clouding, mould or bio-films) and substances regulated by national or European limit or precaution values.
- Releases can be considered as **negligible** when it is ensured that health and environmental related limit and/or precaution values are clearly complied with. In cases where substances that may be released are identified as carcinogenic, mutagenic, toxic for reproduction, very toxic, toxic or dangerous for the environment, but are not regulated by limit or precaution values, no WT classification should be attributed for the time being. In such cases there should be an evaluation by a generally acknowledged expert group involving the responsible authorities.
- For the WT and WFT classification the bandwidth of health and environmentally relevant characteristics of products is considered by defining appropriate **confidence intervals.** A sufficient safety margin to limit values has to make sure that limit values can be complied with by all product variants in a product group, as well as for the case of production or material caused variations. With regard to compliance with precaution values, the confidence interval can be more nar-

---

[7] § 3(1) of the Model Building Code states: “Structures … shall be arranged, erected, altered and maintained in such a way that there is no risk to public safety or order, in particular to life, health or natural resources.” Construction products that are to be used in such construction works must satisfy certain requirements in order to meet the above protection objectives. In this regard, § 3(2) states: “Construction products and designs may only be used if, in respect of their use, structural works, when maintained properly, satisfy the requirements laid down in this Act, or which are based on this Act, for an appropriate period of time which is in keeping with their purpose and are fit for their purpose”.

[8] § 3 (1) of the Federal Highway Act states: “The road construction charges include all tasks related to construction and maintenance of highways. The responsible bodies according to their capacity of performance have to build, maintain, enlarge or improve highways in a way satisfying the transport demand. … other public interests including those of environment protection … are to be considered.

[9] Federal Highway Act from 6th August 1953. Federal Law Gazette I 1953 P. 903. Last revised 20.2.2003. Federal Law Gazette I 2003 P. 286.

[10] See also section 2.1.4

rowly dimensioned, as precaution values usually already include a safety margin. In the case of WFT classification, confidence intervals are specified within the harmonised test standards. In the case of WT classification, confidence intervals have to be judged as satisfactory by the expert group.

- WT and WFT product groups have to be stable and homogenous and stable with regard to emission behaviour and eventually, when relevant, with regard to concentrations of substances regulated in regard to content. Homogeneity can be defined as a comparable composition and/or by referring to a comparable manufacturing process or genesis. Homogeneity has to be clearly described in the product definitions.
- **Intended uses, construction methods and mounting conditions** can be differentiated if they concern different release or emission scenarios with differing significance for health and the environment.
- For the WT classification scientifically validated and acknowledged studies have to be presented or a scientifically acknowledged documentation has to be submitted. The WFT classification is attributed on the basis of harmonised European test standards.
- Lack of information excludes WT or WFT classification. Essential information is in particular knowledge about substance related characteristics, substance related variations within a product group as well as release behaviour.

Formally, WFT differs from WT insofar as for WFT an initial type testing based on harmonised test methods is required, while for WT the generally acknowledged state of knowledge is sufficient. It is also conceivable that for FT products, which have been continuously tested for a longer time, results remain always the same. Based on these test results an application for classification as WFT could be submitted.

In the project the question was posed, which technical criteria would be applicable to differentiate between WT and WFT classification? On the one hand, it was argued that only those products should be classified as WT, which do not contain any dangerous substances or which because of the chemical bond of their ingredients do not emit at all, as, for example, glass panes or ceramic products. On the other hand, it was argued that also products with a more complex composition could be classified as WT, as long as there is a scientifically based state of knowledge, which proves that the products are fundamentally safe for health and the environment.

As a result of the discussions during the project, the possibility of understanding the classification as WT rather broadly was endorsed. It was considered feasible to use the state of knowledge, which is available for a product group as an assessment criterion instead of the complexity of a product. This would conform to the objective of the WT/WFT concept, which is to minimise the burden of testing when it is not essential for the protection of health and the environment. As WFT classification means higher administrative and technical efforts, the WT classification should be allowed as long as it is compatible with health and environmental protection. In this way, testing products for the WFT classification for formal reasons could be avoided when the test results are already predictable. A more generous understanding of WT classification would also honour groups of manufacturers that have already invested in testing and optimisation of their product group.

The next question was which **assessment measures** could be used to allow classification. Construction products have to be safe for health and the environment to comply with the *Essential requirement no. 3.* This applies for products to be classified as WT, WFT as well as FT. The criterion is that emissions or release may not lead to exceeding emission based limit or precaution values and that existing legal requirements for contained substances are met. Harmonised test methods for initial type testing (ITT) have to be developed for this assessment in the context of WFT and FT. For the FT option test methods for factory production control (FPC) are required also.

The question for the time being was, if and which product related criteria could be used for the WT classification. In Germany *The principles for assessment of the effects of construction products on soil and groundwater* of the *German Institute for Structural Engineering* (DIBt) and the *Health-related Evaluation Procedure for Volatile Organic Compounds Emissions (VOC and SVOC) from Building Products* of the *Committee for the Health-related evaluation of building products (AgBB)* are applied (see also section 2.3). These assessment methods should from the German point of view be integrated into the future harmonised test methods.

The above-mentioned methods represent from a technical point of view the generally acknowledged state of the art for the assessment of compliance of products with legal requirements for the environment and human health. Insofar the criteria mentioned above are – at least from the German point of view – appropriate for the classification as safe. As WT and WFT mean that health and environment related requirements of all Member States have to be complied with, it has to be verified, if other Member States have additional or more severe requirements. The strictest requirements are proposed to be applied for a European WT assessment.

Although the criteria in the aforementioned assessment methods could be applicable for a WT / WFT decision, construction products do not need to be subjected to all the tests specified in the assessment methods. The specified criteria merely represent the benchmark. If for a product group it can be shown with a scientific documentation that the specified criteria are certainly complied with, for example, because of the composition or the chemical properties, this should be sufficient for the classification as WT. For product groups with more complex substance related properties, test results with regard to emission behaviour also have to be presented.

Product definitions have a particular importance for the WT classification. The European harmonised standards shall be specifically performance oriented. That means it is not the material properties, but rather the performance characteristics that should be described. This has advantages insofar as the introduction of new manufacturing methods or formulations of products do not require an adaptation of the standards, as long as certain characteristics, for example, the resistance to pressure or to abrasion, remain stable. New formulations, however, may have an effect on the emission behaviour. If product definitions do not give evidence of used substances and used amounts, it seems unavoidable to test products regularly for their emission behaviour. For the purpose of WT classifications, it would be ideal to define products based on detailed recipes. From the manufacturers view, this is not feasible.

What at first sight looks like an unsolvable contradiction could in practice be solved by pragmatic means. Many standards contain (with regard to other essential requirements) substance and material related definitions and limitations, without putting in question the principally performance oriented character of the standards. Standards

contain, for example, information concerning used source materials (which frequently have to comply with requirements in separate standards) or else a definition of maximum content, for example, the content of sulphate in aggregates for concrete. Another example of a definition of a maximum content of substances that is applied without any problems are organic components in mineral-based mortars and plasters as a criterion for fire performance class A1.

Descriptive solutions should also be used in product standards to deal with dangerous substances. For example, the descriptive indication that certain product groups are not designed for indoor use or that certain source materials are not used at all, could be applied to fulfil the *Essential requirement no. 3* in a pragmatic way. Substance related product definitions and descriptive requirements could contribute in a simple way to demonstrating the safety of construction products for health and the environment as well as enabling a WT classification.

The *Expert Group for Dangerous Substances in the field of Construction Products* of the European Commission has a key role for WT classification, as at the present time there is much less experience with the assessment of the health and environment related performance than there is with the assessment of other technical characteristics. In the future, it is also conceivable that manufacturers themselves carry out classifications. For the time being, it is essential that an impartial committee with specific competence decide upon WT applications, and that questions, which cannot be anticipated in advance, are solved in collaboration with the applicants.

The documentation that accompanies an application for WT classification will be different from product group to product group and depends on the complexity of the product group. The elements mentioned in what follows should generally be part of an application for WT classification:

1. Description of the product group to be classified as WT:
    - Specification of the standards which cover the product group
    - Product definition, which describes the stability of the products with regard to health and environment related characteristics.
    - Description of the manufacturing process, the substance related composition and/or the „frame recipes“. This in particular includes information on used source materials, as well as the applied requirements concerning their quality and purity.
    - Plausible demonstration that the application includes information on all the products on the market covered by the relevant product standard(s).
    - Information on the standards which (if any) cover precursor products relevant to the health and environment related characteristics of the products.
    - Intended uses and construction methods.
    - Permissible/likely variations in the product during manufacture (where defined in the standards) or variations with regard to used source materials.
    - Information if the use of secondary raw materials is admissible and how legal requirements with regard to waste are complied with.
2. As far as applicable: the adapted product definition as envisaged in a revision of the standard in order to reach a WT classification, as well as the descriptive re-

quirements, for example, on the use or the limitation of certain source substances, certain intended uses or construction methods.

3. Scientific documentation explaining why the product group is safe for health and the environment. According to the complexity and the characteristics of the product group, this may be a simple documentation or one supported by studies and test results. Test results have to be derived from acknowledged test methods and the tests have to be performed by acknowledged test or scientific institutes. Results derived from national as well as from European test methods can be used.

In summary, three conditions need to be met for WT classification:

- A generally acknowledged assessment method as a benchmark for the classification
- Specified product definitions ensure that the products covered are stable with regard to their health and environmental related performance.
- Scientific documentation, technical reports and/or scientifically acknowledged test results presented to the Expert Group prove the safety of the product (group) for health and the environment.

2.3 Health and Environmental Related Assessment Measures for WT or WFT Classification

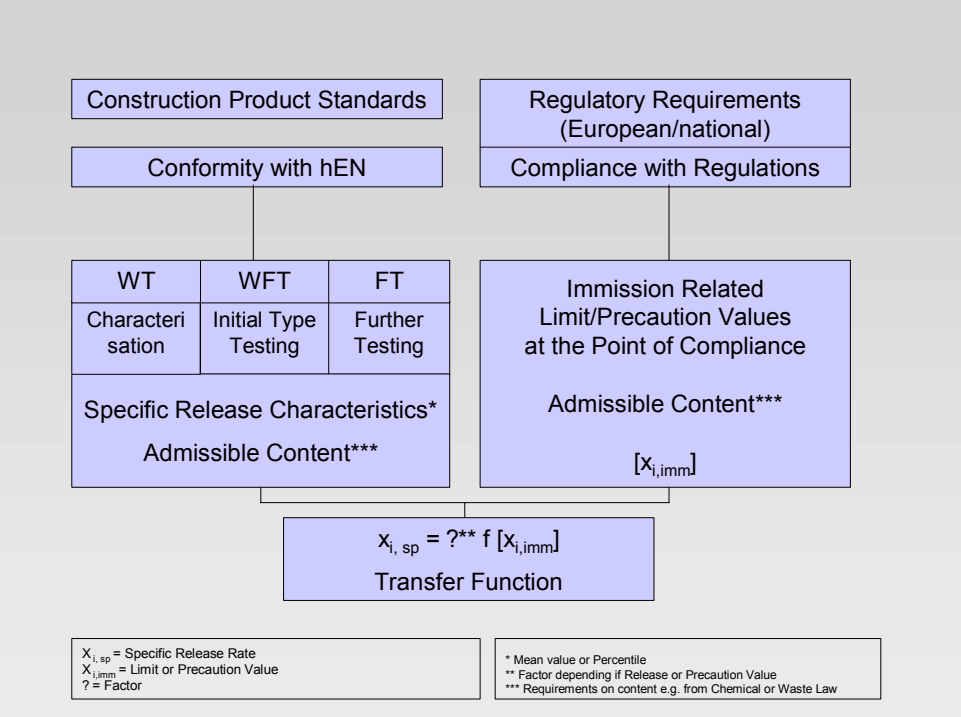
Construction products in the sense of the Essential Requirement No. 3 may not cause any hazard to health and the environment. In Germany, this principle is laid down in the *Model Building Code* and in the *Federal Highway Law*.

In the first approach, the protection of health and the environment is immission related. Regulations define which concentrations have to be complied with in environmental compartments and in human living space to exclude hazardous effects. To achieve harmless immission values source related regulations are applied aiming at the reduction of related emissions. This includes regulations with regard to both point sources, and diffuse sources like products.

In defining product related emission values, the real contributions of products to the immission values should be accounted for. In practice, however, convention based simplifications have to be accepted to minimise the effort of testing and verification. In Germany, specific health and environmental requirements for construction products have followed the development of environmental regulations. Specifications, which define in general the emissions from construction products that are admissible and how to measure them, have been only recently determined for major construction product groups.

The following figure shows the relationship between health and environment related limit and precaution values and product related requirements:

Figure 4 – Transfer of health and environmental regulations to product requirements



Source: Adapted after [DIJKSTRA 2005]

In what follows the health and environmental related body of regulations in Germany is outlined in relation to construction products.

2.3.1 The Legal Basis

Soil Protection Law

The *Federal Soil Protection Act* (BBodSchG)[11] and the *Federal Ordinance on Soil Protection and Contaminated Sites* (BbodSchV)[12] regulate soil protection issues. The purpose is to safeguard or to restore the functions of the soil: harmful changes to the soil shall be prevented, contaminated sites as well as bodies of water contaminated through such sites are to be cleaned up, and precautions taken to prevent detrimental effects on the soil. Impairment of the natural functions of the soil as well as of its function as an archive of natural and cultural history shall be prevented as far as possible.

The essential principle of the BBodSchG is the obligation to take precautionary action. In accordance with Section 7 BBodSchG, “The property owner, the occupant over a site and the party who carries out, or has carried out by others, actions on a site that can lead to changes in soil characteristics are obligated to take precautions against the occurrence of harmful soil changes that could be caused by their uses of the site or in its area of influence. Precautionary measures shall be required if there is concern that harmful soil change could occur as a result of the spatial, long-term or complex impacts of a use on the soil's functions. In order to fulfil the obligations to take precautions, soil

[11] Federal Soil Protection Law of 17 March 1998 (Federal Law Gazette I p. 502)

[12] Federal Soil Protection and Contaminated Sites Ordinance of 12 July 1999. (Federal Law Gazette I p. 1999 p.1554). Last revised on 23 December 2004 (Federal Law Gazette I p.3758)

impacts shall be avoided or reduced where this is a reasonable requirement also with respect to the purpose of the use of the site."
Which requirements construction products have to comply with and how the assessment of the harmlessness of construction products can be carried out to comply with the obligation of precaution has been defined in the *Principles for assessment of the effects of construction products on soil and groundwater* of the DIBt.

Water Law

The principle of Section 1a(2) of the *Federal Water Act* (WHG)[13] places an obligation on everyone, when taking action which may have an effect on a body of water, to take the necessary care according to the circumstances to prevent contamination of the water or any other detrimental change to its properties.

However, if the use of construction products or a construction measure is likely to cause permanent or not inconsiderable harmful changes to the physical, chemical or biological nature of the water, this constitutes "other use", which requires permission under water law. If, however, it is generally known that certain measures cause merely inconsiderable harmful changes, i.e., when seepage water is only inconsiderably contaminated, no permission under water law is required.

The *European Water Framework Directive (WRRL)*[14] requires that a good chemical state of the groundwater has to be maintained or restored.

Which changes with regard to water and soil can be considered generally negligible, has been defined by the *Working Group of the German Länder on Water Issues (LAWA)* in the *Principles of Pre-emptive Groundwater Protection With Waste Recycling and the Use of Products (GAP-Report)* [LAWA 2002] which also defines "insignificance thresholds". Insignificance thresholds define maximum concentrations to be complied with at the point relevant for compliance. They have to be taken into consideration when assessing the harmlessness of primary and secondary materials used in construction products for the quality of groundwater. The *GAP-Report* also considers the precautionary obligations deriving from *Soil Protection Law*.

Waste Law

In accordance with the principles of waste management (Section 4 of the *Waste Avoidance, Recovery and Disposal Act*[15], waste shall primarily be avoided, and secondarily recycled or used for obtaining energy (energy recovery). Waste recovery, especially binding of waste within products, must take place properly and safely. Recovery takes place properly when it complies with public-law provisions. It takes place safely when, given the waste's nature, the extent of the impurities the waste contains and the type of recovery in question, no impairment of the public interest is expected, and, in par-

[13] Act on the Regulation of Matters Pertaining to Water of 19 August 2002 (Federal Law Gazette I p. 3245). Last revised on 25 June 2005 (Federal Law Gazette I No. 37 p. 1746).

[14] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy of 23 October 2000. (OJ L 327 , 22.12.2000 p. 1) .

[15] Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal (Federal Law Gazette I 1994 p. 2705) Last revised 1 September 2005 (Federal Law Gazette. 2618).

ticular, when no accumulation of harmful substances occurs within the recovered substance cycle.

For the use of inorganic waste as or in construction products recycling is regarded as safe, if the undiluted waste complies with the allocation criteria laid down in *LAGA Communication 20 (LAGA-Rules)* [LAGA 1998].

Radiation protection law

Whereas previous regulations only covered man-made radiation the new Radiation Protection Ordinance[16] (Strahlenschutzverordnung, StrlSchV), which entered into force 2001, also includes raised levels of radiation from natural sources. The new Radiation Protection Ordinance reduces the exposure values for the population to one millisievert (mSv) per year.

Chapter 3 of Part 3 of the *Radiation Protection Ordinance* (StrlSchV) contains provisions concerning residues, which may contain natural radionuclides with increased specific activities. When such residues are used for example for house building, road construction, landscaping or hydraulic engineering, the exposure of individuals to radiation may increase considerably in comparison to the level naturally present in the environment. This additional effective dose has to be kept under one mSv per year.

Natural mineral construction products may contain radioactive substances, in particular Radium-226, Thorium-232 and Kalium-40. The provisions of the *Radiation Protection Ordinance* do not define regulations concerning natural mineral materials. The denominated values, however, are suited as an assessment measure for the verification of a construction product's fitness for use.

Chemical law

In the Prohibition of *Chemicals Ordinance*[17], and respectively, in the *EC Restriction Directive 76/769/EWG*[18], a number of substances are banned or restricted, some of them having significance also for construction products. These include, for example, asbestos, formaldehyde in wood based panels (not regulated at EU level), lead carbonates and lead sulphates, mercury, arsenic, organic tin compounds, cadmium, vinyl chloride, pentachlorophenol (not regulated at EU level in products), tar oils, bio persistent fibres (not regulated at EU level) and CMR substances (carcinogenic, mutagenic or toxic for reproduction). It has to be observed that in some cases, e.g. for formaldehyde or bio persistent fibres requirements differ in the EU Member States.

---

[16] Radiation Protection Ordinance (German designation: Strahlenschutzverordnung, StrSchV) of 20 July 2001 (Federal Law Gazette I 2001 p. 1714). Last revised 1.9.2005 (Federal Law Gazette I p.2618).

[17] Order on bans and restrictions regarding the distribution of dangerous substances, preparations and goods according to the Chemicals Act (German designation: Chemikalien-Verbotsverordnung – ChemVerbotsV) of 13 June 2003. Federal Law Gazette I p. 867) last revised on 21 June 2005. Federal Law Gazette I, No. 35, p. 1666.

[18] Council Directive 76/769/EEC of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations of 27 septembre 1976. OJ L 262, p. 201. Last revised with directive 2005/90/EG of 18 January 2006 (OJ No. L 33 p.28).

According to the *Biocidal Products Directive 98/8/EG*[19], biocides have to be approved or registered. „Existing biocidal products“ have to be registered and assessed before 2010. In Germany, during this transition period there is a duty of notification for existing biocidal products. According to the *Biocide Notification Ordinance (ChemBiozid-MeldeV)*[20] on the notification of biocidal products, all existing biocidal products had to be notified by 28.7.2005 at the latest. After assignment of a registration number not later than 28.2.2006, the Federal Institute for Occupational Safety and Health (BAuA) as the acting approval body will publish a list of notified biocide products in the Federal Law Gazette. Under the 23 product types listed in Annex V of the *Biocidal Products Directive* for intended used, in-can preservatives (Product-type 6), wood preservatives (product-type 8) and masonry preservatives (Product-type 10) may be relevant for construction products.

From 2010 onwards, all biocides placed on the market in Europe must be authorised and approved. After 2010, products might still emit volatile biocides, but no critical substances should be in use any more. With the publishing of the list of registered biocides[21], information is available, as to which biocidal products are in use in Germany.

Indoor air regulations

For indoor air in non-commercial spaces, i.e., those spaces for which regulations of occupational safety are not applicable, there is no immediately applicable immission protection law. For certain substances there are two-stage guideline values. Guideline Value I represents the maximum concentration of a substance in indoor air that is not expected to harm health during a lifelong exposure. Guideline Value II represents the concentration of a substance, above which immediate action is required, since a continuous exposure may cause a health hazard for sensitive persons. Concentrations between Guideline Value I and Guideline Value II require diminution action for precautionary reasons. Single substance guideline values are defined for toluene, dichloromethane, carbon monoxide, pentachlorophenol, nitrogen dioxide, styrene, mercury, tris(2-chlorooethyl)-phosphate, bicyclic terpenes, naphthalene and aromatic reduced hydrocarbon compounds (C9-C14) [UMWELTBUNDESAMT 2006].

The parameter “total organic volatile compounds (TVOC)” expresses multiple volatile organic compounds occurring in interiors and emitting from different sources. As the TVOC-value is the sum of different substances, the uncertainty with regard to the assessment of the health effects is much higher than in the case of a single substance. To account for this, TVOC guideline values are not accurate values, but ranges of concentrations.

The guideline values for indoor air are relevant for the assessment of construction products, which present one of the major sources for immissions of volatile organic compounds into indoor air.

---

[19] Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market (OJ No. L 123 p.1).

[20] Verordnung über die Meldung von Biozid-Produkten nach dem Chemikaliengesetz (Biozid-Meldeverordnug – ChemBiozidMeldeV) vom 24. Mail 2005 (BGBl. I S. 1410).

[21] http://www.baua.de/nn_14552/de/Chemikaliengesetz-Biozidverfahren/Dokumente/Wirkstoffe-plus.pdf

2.3.2 Product Related Regulations and Assessment Methods with Regard to Soil and Groundwater

The basis for the assessment of the harmlessness of construction products in relation to soil and groundwater are the *Principles of pre-emptive groundwater protection with waste recycling and the use of products* (*GAP-Report*) and their thresholds of insignificance values (ToI-Values) developed by the *Working Group of the German Länder on Water Issues* (LAWA).

ToI-Values define maximum concentrations at a point of compliance. For example for structural foundations in the unsaturated zone that may cause a substance input by way of leachate the point of compliance is the upper edge of an existing cohesive layer. For construction products that can be emplaced not only in the unsaturated but also in the saturated zone the place of assessment is the area of contact between the material and the flowing groundwater. For construction works above the groundwater, this is of relevance only when the products in question are water permeable and seepage water can be generated. ToI-values have to be applied for the assessment of harmlessness when using primary and secondary construction materials, if they might cause a detrimental alteration of the groundwater. Not having an immediate legal validity, they are taken into consideration when drafting technical rules, which are specified in consent with the Working Group of the German *Länder* on Water Issues (LAWA). The full specification of product related use rules with according allocation values is still pending.

If secondary raw materials are used, the requirements according to the LAGA Communication 20 "Requirements for Re-use/Utilization of Inorganic Residues/Wastes – Technical Rules " (LAGA-Rules) [LAGA 1998] have to be complied with at present.

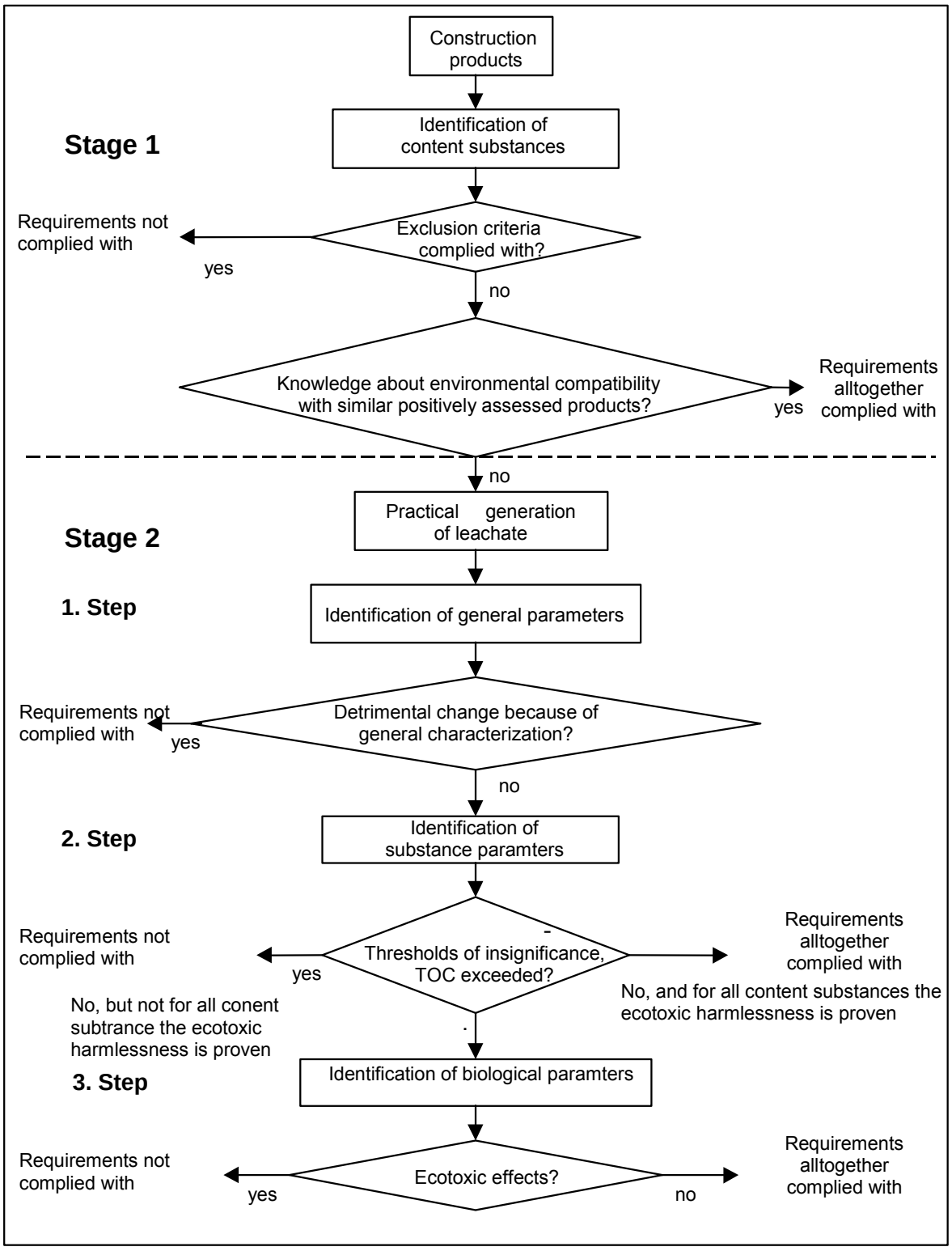
In the *Principles for assessment of the effects of construction products on soil and groundwater* (Principles for Soil and Groundwater) of the DIBt [DIBT 2006a] a general procedure and criteria for the assessment and testing of construction products is given, also including the test methods to be applied. The *Principles for Soil and Groundwater* was developed for use in the field of national technical approvals. They are also applicable for an environmental approval of construction products regulated by harmonised European standards, which have not yet implemented *Essential requirement no. 3*. The *Principles for Soil and Groundwater* already takes into consideration theToI-Values.

The *Principles for Soil and Groundwater* does not have an immediate formal validity for the assessment of standardised construction products or for the assessment of road construction products. These principles represent, however, the state of the art agreed among the responsible authorities for the product related implementation of the water, soil protection and waste law. Therefore, in this publication they function as a measure for the classification as safe. Construction product groups, which in their entirety comply reliably and permanently with the designated criteria, are in general considered safe for soil and groundwater.

If it is not certain, whether a product complies wit the ToI-Values, because of currently lacking specific product related allocation values for WT classification, reconciliation with the responsible authorities might be required. Moreover, there are further release scenarios, which are significant for soil and groundwater and, which are not yet included in the *Principles for Soil and Groundwater*, for example, the input of rainwater running down external walls. An overview of relevant scenarios is presented in the report *How to Judge Release of Dangerous Substances from Construction Products to*

Soil and Groundwater [DIJKSTRA 2005]. The following flowchart shows the assessment scheme of the *Principles for Soil and Groundwater*:

Figure 5 - Assessment scheme according to the Principles for assessment of the effects of construction products on soil and groundwater



Source: [DIBT 2006a]

2.3.3 Product Related Assessment Methods with Regard to Indoor Air

The basis for the testing and assessment of construction products effects on indoor air quality in Germany is the assessment scheme "*Health-related Evaluation Procedure for Volatile Organic Compounds Emissions (VOC and SVOC) from Building Products*" (AgBB Scheme). The *Committee for Health-related Evaluation of Building Products* [AGBB 2005] has developed the scheme. It defines which emissions from a construction product can be considered as not hazardous to health.

The measuring is based on a standardised test chamber measurement according to the draft standard prEN 13419[22]. I.e. the procedure applies a European test method. It is also becoming apparent that other European states are introducing the assessment of VOC emissions in a comparable way [AGBB 2004]. The AgBB Scheme is the basis of the *Principles for the health assessment of construction products used in interiors* of the DIBt, applied, for example, for floorings [DIBT 2005].

In recent years both manufacturers and authorities have had different product groups, (e.g. floorings, adhesives, wall coverings, paints/lacquers, ready-to-use plastering, insulation materials and sealing compounds) tested according to the assessment scheme and experience has been gained [AGBB 2004;GELLERT 2006]. This contributes to the validation of the testing method, as applied within the assessment scheme, as well as to the consolidation of the different conditions to be applied for different products, as for example, the preparation of the samples or the point in time to start the measurement.

Manufacturers have encouraged developing a faster method for VOC measurement. As test chamber measurement takes 28 days, it brings with it accordingly high costs. The costs of a 28-day measurement lie in the order of € 3.000. This is to justify for initial type testing (ITT) or for characterisation testing, but for further testing / factory production control (FPC) this would be too laborious and time-consuming.

An earlier abortion of the test chamber measurement – and with it a reduction of costs – is possible when initial emissions are low. However, this requires a good knowledge of the product specific emission behaviour. The DIBt commissioned a research project on developing a simplified method [FHI 2006].

For the desired implementation of the AgBB Scheme and the denominated testing methods as harmonised test method for standardised construction products, further product specific operating experience and adaptations are still necessary, as well as a simplified test method for further testing / FPC. WFT classification of products with regard to indoor air emissions will be possible, when methods for ITT harmonised under mandate M/366 are available.

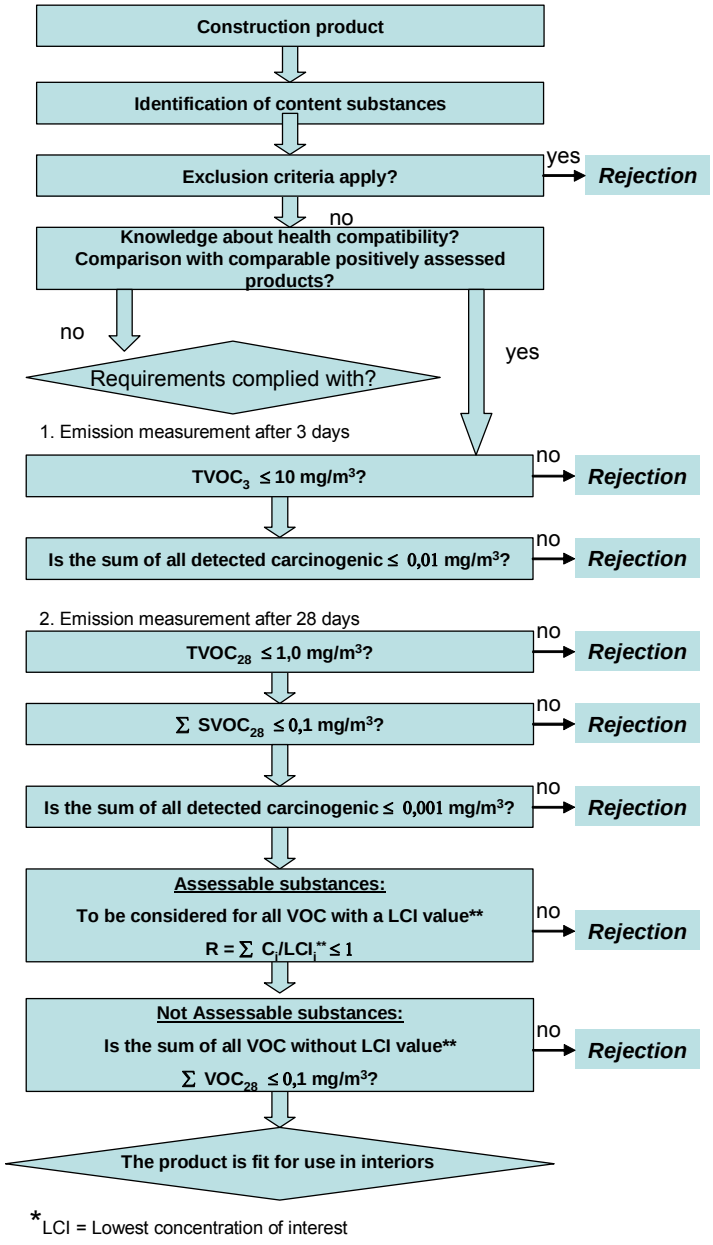
For the classification of standardised product groups, the AgBB Scheme is already today a suitable assessment method. A WT classification for indoor air is acceptable when a product group complies in its entirety with the denominated criteria due to its

[22] In 2006 the standard prEN 13419, Parts 1-3, has been conveyed into the standard EN ISO 16000, Parts 9 – 11: Indoor air. Determination of the emission of volatile organic compounds from building products and furnishing (Part 9 – Emission test chamber method; Part 10 – Emission test cell method; Part 11 – Sampling, storage of samples and preparation of test specimens).

composition or when scientifically based tests prove that values and criteria are fulfilled with sufficient reliability.

The following figure shows the different evaluation steps of the *Principles for the health assessment of construction products used in interiors* of the DIBt:

Figure 6 - Health-related Evaluation Procedure for Volatile Organic Compounds Emissions (VOC and SVOC) from Building Products



Source: [DIBt 2005, own translation]

3 Plasters, Mortars and Gypsum Boards for Internal Use

Within the project, plasters, mortars and gypsum boards serve as exemplary product groups for indoor use. For classification as WT, the project team and the involved stakeholders evaluated, whether the indoor air emissions of a product group are low enough to exclude health hazards. If it would not be possible to come to a positive answer, the next alternative to consider would be WFT classification based on a characterisation test with harmonised European test methods.

3.1 Product Groups: Use and Amounts

Standards do not define the term mortar consistently. A general definition can be: „**Mortar** is a mixture of aggregates with a maximum particle size of 4 mm (in exceptional cases up to 8 mm) with one or more binders and eventually with admixtures and additives. Mortars with inorganic binders additionally contain water“. Mortars have different application areas; the most important ones are masonry mortar, plastering/rendering mortar, screed materials and adhesives for tiles.

In Germany, mortars mixed on-site are today rare. It is common to deliver factory-made mortars that are ready for use. The following **forms of delivery** are distinguished:

- Factory made dry mix mortar is a ready-to-use mixture of the source materials. For the preparation on-site only water is added to achieve a processable consistency. Factory made dry mortar is deliverable in silos or in sacks.
- Factory made mix mortar is deliverable in processable consistency ready to use with truck mixers. It is discharged to troughs and as a rule remains processable for 36 hours.
- Factory made premix mortar is a factory made mixture of sand and lime and eventually other additions. At the building site, cement and water have to be added to the premix mortar “dumped off” by a lorry. Factory made premix mortar is common especially in Northern Germany.
- In the case of multi-chamber silo mortar, multiple chambers separate the source materials. They are dispensed to a mixer situated under the silo and processed to be taken from the mixer outlet.

Masonry mortar is a mortar, which is used in masonry for the setting up of the horizontal, transversal and longitudinal joints as well as for the subsequent joint filling. It has the function of ensuring a uniform power transmission from brick to brick. At the same time, it levels the dimension tolerance of the bricks and closes the gaps between them. In Germany exclusively mineral mortars are used as masonry mortar; this means that cement and/or lime is used as binder. For the optimisation of the processing and material properties, admixtures can be added, for example, retarding, accelerating or air entraining agents.

Plaster/render is a one or multi layered coating made of plastering/rendering mortars applied on walls or ceilings. This product reaches its final characteristics only after hardening on the surface of the building structure. Mineral plastering/rendering mortars contain as binder lime, cement, anhydrite and/or gypsum. Quantitatively, the greatest components are the mineral aggregates such as limestone, marble or quartz with a

preponderant particle size between 0,25 and 4 mm. The standard DIN V 18550 classifies plastering/rendering mortar types according to the used binders (Table 1).

Table 1– Groups of plastering/rendering mortar types according to DIN V 18550

Mortar Group	Type of Mortar
P I	Air-hardening lime mortar, water lime mortar, mortars with hydraulic lime
P II	Lime cement mortar, mortar with highly hydraulic lime or with masonry cement
P III	Cement based mortar with or without addition of lime hydrate
P IV	Gypsum und gypsum based mortars

Mineral renderings (external, binder lime and/or cement) are insensitive to dampness. An “aging” due to UV-radiation or due to dampness, as is known for some synthetic resins, does not occur for mineral construction materials. Mineral plastering/rendering mortars are solvent-free and do not need preservatives or any biocides for conservation. Mineral plastering/rendering mortars show a fine pored, vapour permeable texture, which facilitates an optimal dampness balance in external facades and in interior spaces.

Besides the inorganic rendering/plastering mortars, silicate, silicone and other resin based rendering/plastering mortars are available. These **organic plasters/renders** contain organic binders, mineral aggregates, fillers, pigments and other additions or admixtures. They are delivered as paste (can). Mostly they are applied as decorative thin layer plasters in coat thicknesses of 3 mm. They are normally white, but can be painted over with emulsion paints in any colour. Naturally colourful are coloured stone plasters made of stone granulates. Organic plasters/renders are suitable for many purposes. Manufacturers describe them as highly weatherproof, resistant and robust, UV-stable and vapour permeable.

Plasters and renders have different functions. Internal plasterings and external renderings are distinguished according to their field of application.

Plasters: The most important functions of plastering consist in the manufacturing of even and planar surfaces, as well as in the creation of a temporary accumulator for excessive interior dampness. Traditional plastering consists of several coats. Besides the multi-layer plastering, more and more one-layer plastering is used. Mineral plastering is mostly produced with gypsum and/or lime as binder. Lime cement plastering mortars are also applied. Internal wall and ceiling plasters used in wet locations have to be resistant to long-term effects of dampness. Gypsum based plasters may not be used in damp and wet locations.

Renders are an important part of the external wall. Their relevant functions are the protection of the external wall from the penetration of water, the thermal insulation and the aesthetic design of the facade. Renderings are stressed by precipitations, temperature, mechanical impacts, water vapour diffusion, and residual stress because of shrinking and of deformation of the subsurface and eventually by tensions from applied coatings. Renderings are produced by machine application of the rendering mortars on the facade; sometimes the application is carried out by hand. Usually rendering systems

consisting of a base coat and a finishing coat are applied. For the production of base coats, almost only mineral mortars are applied. As a finishing coat, mineral or organic rendering mortars are used.

Screed is a construction part applied on a load-bearing surface or on an intercostal separation or insulation layer, which can be used as it is or covered with flooring. Screeds are produced from screed materials with a maximum particle size of eight mm. Screed material is defined as the basic mixture consisting of binders and aggregates and eventually liquids, which facilitate the hardening of the binder, also with additives and/or admixtures. For the production of the screed material, the European standard EN 13813 is applied. Binders admissible according to this standard include calcium sulphate, bitumen, resins, caustic magnesia or cement. Depending on the binder used, there can be either:

- Calcium sulphate screed
- Mastic asphalt screed
- Magnesite screed
- Synthetic resin screed
- Cementitious screed

In Germany, the screed materials that are predominantly used are cementitious screed or calcium sulphate screed. In Germany, about 60% of the floor screeds applied are still produced from screed materials mixed manually on the construction site. More and more factory made dry mix mortar, mix mortar and multi-chamber silo mortar are also used. Screed material for cementitious screed is produced from cement (according to a standard or to a technical approval), mineral aggregates, water, eventually admixtures, and additives. Cementitious screeds are suitable for exteriors and interiors as well as for continuously wet locations as they are not damp sensitive. For flowing screed, calcium sulphate, anhydrite and/or α-half hydrate ($CaSO_4 \cdot ½ H_2O$) is used as binder. The use of calcium sulphate screeds is limited to interiors. The other types of screeds (mastic asphalt screed, magnesia screed and synthetic resin screed) are rarely used in Germany. The following tables show the amounts produced in Germany:

Table 2– Development of the market for masonry, plastering/rendering mortars and screed materials (in 1000 t)

Product type	2001	2002	2003	2004
Masonry mortar	3.382	2.934	2.936	2.779
Plastering/Rendering	5.285	4.781	4.745	4.672
Screed	6.809	6.064	6.244	6.032
Other mortars	3.060	3.187	3.138	3.094
Total	18.537	16.967	17.063	16.577

Source: Industrieverband Werkmörtel

Table 3– Production of factory-made dry mix mortars (in 1.000 t)

Product type	2003	2004	Difference %
Screed materials	971	978	+ 0,8
Masonry mortar	1.970	1.966	- 0,2
Plastering mortar	545	566	+ 3,9
Rendering mortar	1.825	1.781	- 2,5
Finishing mortars	249	245	- 1,5
Dry mix concrete/spray concrete and other dry mix mortars	901	941	+ 4,4
Total	6.178	6.478	+ 0,3

Source: Internal statistical system of the industry association of factory made mortars.

The group of **modified mineral mortar systems** includes a variety of chemical products, e.g. waterproofing slurries, adhesives for tiles, joint mortars, filling compounds and repair mortars for repairing concrete. In the project, only tile cements according to EN 12004 and modified screed materials were looked at. Cement based adhesives are a mixture of hydraulic binders, aggregates and organic admixtures. The mortar is mixed shortly before use with water or with liquid additives. Dispersion tile adhesives are mixtures of organic binder in form of watery polymeric dispersion, organic additions and mineral fillers. The mixtures are ready for use.

Gypsum boards are applied in interiors as dry mortarless constructions for partition walls and claddings. **Gypsum plasterboards** are factory-made construction panels, consisting primarily of plaster of Paris (half hydrate) whose surfaces and longitudinal edges are firmly bonded to strong durable paper liners. They may contain additions, e.g., for hydrophobation or inorganic fibres for the optimisation of fire performance. Gypsum plasterboards are used in particular for wall and ceiling claddings, sheathing and for the production of prefabricated construction parts. Manufacture is carried out industrially on assembly lines by applying the gypsum slurry on the paper liner and subsequently drying the product in continuous flow dryers. Gypsum plasterboards can be further processed industrially, e.g. into perforated boards.

Gypsum blocks are construction elements for non load-bearing construction parts made from plaster of Paris and water. They are used for example for partition walls or for cladding of columns. Gypsum blocks may contain fibres, fillers and aggregates, additions and admixtures and may be coloured for optical differentiation by pigments. For the assembling, the edges are provided with tongue and groove and they are joined using gypsum adhesives. The adhesives used for the jointing and fillers contain specific admixtures to achieve the desired processing characteristics [BUNDES-VERBAND DER GIPSINDUSTRIE E.V. 2003]. Gypsum blocks are manufactured industrially by filling the gypsum slurry in forms and subsequently drying the blocks in continuous flow dryers. For damp locations, hydrophobised variants are used.

In 2003, 255 million m^2 of gypsum plasterboards and fibrous gypsum boards were produced in Germany. The total gypsum production amounted to 9 million tons, whereas about 90% went into the production of gypsum boards, fibrous gypsum boards, screeds and plasters [DROSSER 2005].

3.2 Technical Regulations and Health and Environment Related Requirements

3.2.1 As WT Candidates Discussed Product in the Field of Plasters, Mortars and Gypsum Boards

The following mandates cover standards for plasters, mortars and gypsum boards:

- Mandate M/106 Gypsum products
- Mandate M/116 Masonry and related products
- Mandate M/127 Construction adhesives

Moreover, components of plasters and mortars are covered in the mandates:

- Mandate M/125 Aggregates
- Mandate M/128 Products related to concrete, mortar and grout

Appendix C.1 shows the mandates relevant to plasters, mortars and gypsum boards with their intended uses and the relevant families and sub-families.

In the two workshops concerning plasters, mortars and gypsum boards, representatives of industry and authorities agreed on which product groups should be closely looked at as WT or WFT candidates. It was proposed to consider gypsum boards in addition to plasters and mortars, as they are comparable in composition to gypsum-based plasters. Mineral bound screeds and adhesives for tiles were also included. The following table shows the product groups, which were discussed in the workshops as exemplary WT candidates. Apart from the organic systems for rendering and plastering mortars according to EN 998-3, the main components of all the systems considered are composed of mineral binders, aggregates, additives and admixtures. Organic binders are also added to modified mineral systems.

Table 4 – Proposed product groups for WT classification

EN	Masonry and Plastering Mortars	Mandate
998-1	Specification for mortar for masonry – Part 1: Rendering and plastering mortar	M/ 116: mortars for interiors
998-2	Specification for mortar for masonry – Part 2: Masonry mortar	
998-3	Definitions and specifications for masonry and related products - Part 3: Organic products for external rendering and internal plastering	
EN	**Plasters**	
13279-1	Gypsum binders and gypsum plasters - Part 1: Definitions and requirements	M/106
12860	Gypsum-based adhesives for gypsum blocks - Definitions, requirements and test methods	
13963	Jointing materials for gypsum plasterboards - Definitions, requirements and test methods	
14496	Gypsum-based adhesives for thermal/acoustic insulation composite panels and plasterboards - Definitions, requirements and test methods	
EN	**Screeds**	
13813	Screed material and floor screeds - Screed material - Properties and requirements	M/119: cementitious, calcium sulphate + magnesite screeds.
13454-1	Binders, composite binders and factory made mixtures for floor screeds based on calcium sulphate - Part 1: Definitions and requirements	M/106
14016-1	Binders for magnesite screeds - Caustic magnesia and magnesium chloride - Part 1: Definitions, requirements	M/119
EN	**Adhesives for tiles**	
12004	Adhesives for tiles - Definitions and specifications	M/127: cementitious and dispersion adhesives for tiles
EN	**Gypsum boards**	
520	Gypsum plasterboards - Definitions, requirements and test methods	M/106
12859	Gypsum blocks - Definitions, requirements and test methods	
13815	Fibrous gypsum plaster casts - Definitions, requirements and test methods	
13915	Prefabricated gypsum wallboard panels - Definitions, requirements and test methods	
13950	Gypsum plasterboard thermal/acoustic insulation composite panels - Definitions, requirements and test methods	
14090	Gypsum plasterboard products from reprocessing — Definitions, requirements and test methods	
14209	Preformed plasterboard cornices - Definitions, requirements and test methods	
14246	Gypsum elements for suspended ceilings - Definitions, requirements and test methods	
15283-1	Gypsum boards with fibrous reinforcement - Definitions, requirements and test methods - Part 1: Gypsum boards with mat reinforcement	
15283-2	Gypsum boards with fibrous reinforcement - Definitions, requirements and test methods - Part 2: Gypsum fibre boards	

The German CEPMC member organisation, Bundesverband Baustoffe — Steine und Erden e.V. (Federal Association of Construction Materials), and further participants

from industry proposed in addition the following product standards, although these were not considered in detail in the workshop. As most of them are product groups with comparable basic composition, (made of mineral binder, aggregates, additives and admixtures), it is conceivable that the results of the project can be transferred to these products.

Table 5– Further proposals of product groups for WT classification

EN	Title	Mandate/Comment
EN 206-1	Concrete – Part 1: Specifications, performance, production and conformity	M/128
DIN V 1015-1,-2,-3	Masonry units	(M/116)*
EN 105-3,-4	Masonry units	M/116
EN 771-1	Specification for masonry units - Part 1: Clay masonry units	M/116
EN 105-5 und -6	Clay bricks; lightweight horizontally perforated bricks and lightweight horizontally perforated brick panels; Clay masonry units - Part 6: High precision units	M/116
DIN V 105-100	Clay masonry units - Part 100: Clay masonry units with specific properties	(M/116)*
DIN V 4165	Autoclaved aerated concrete masonry units - Part 100: High precision units and elements with specific properties	(M/116)*
DIN 4166	Autoclaved aerated concrete slabs and panels	(M/116)*
DIN 4223	Prefabricated reinforced components of autoclaved aerated concrete	(M/116)*
EN 13162	Thermal insulation products for buildings - Factory made mineral wool (MW) products - Specification	M/103
EN 1504	Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity	M/128 Only polymer cement concrete (PCC)
* Products covered by mandate, but standards referred to are not subject to the mandates		

3.2.2 Relevant Health and Environmental Related Requirements for Plasters, Mortars and Gypsum Boards in Relation to Indoor Air

Environmental related requirements do not play any role for products used in interiors during the use phase, as there is no direct contact with soil or groundwater. In relation to indoor air, however, they might contribute to the immission of volatile organic compounds, inasmuch as such compounds are used for the production of the products. As they are applied to large surfaces, even low emissions per surface could amount to significant emissions.

Inasmuch as plasters and mortars, (with the exception of the organic plasters), consist primarily of mineral components, which do not play any role in charges to indoor air, only the organic components could contribute to such emissions. In comparison with other heavy emitting products, such as adhesives for floorings, plasters and mortars until now have been scarcely analysed in relation to indoor air emissions; they have been evaluated as relatively unproblematic. Therefore, at the beginning of the project it

was not known which components are used for the production of these product groups, and to what extent they contribute to VOC emissions. Nor is it known, to what extent formaldehyde is emitted (if at all). For formaldehyde, however, a limit value is applicable only to wood based panels, but since the International Agency for Research on Cancer (IARC) has classified formaldehyde as carcinogenic for humans, it makes sense to consider formaldehyde emissions within the WT classification.

Natural mineral materials may contain radioactive substances, in particular radium-226, thorium-232 und potassium-40. Therefore, for mainly mineral construction materials the question of radioactive radiation in principle has to be asked. However, until now there have been no legally binding limit values for natural mineral materials.

Furthermore, requirements of the *Chemical Law* have to be considered. For construction products, this concerns in particular the ban on carcinogenic, mutagenic and reproduction toxic substances according to Directive 76/769/EG; this is binding, however, only for preparations, which are designed for the end user.

Biocides have to be authorised or registered according to the *Biocidal Products Directive 98/8/EG*. Existing biocidal products have to be notified and assessed by 2010. Among the 23 product types named in Annex V of the *Biocidal Products Directive* in-can-preservatives (product type 6) and masonry preservatives (product type 10) could be significant for plasters and mortars. From 2010, only authorised or registered biocides would be applicable to plasters and mortars. After 2010, biocides could still be emitted and contribute to indoor air charges, but critical substances shall be excluded. From 2006 in Germany, the Federal Institute for Occupational Safety and Health (BAuA) provides information on existing biocides based on the *Biocide Notification Ordinance (http://www.baua.de).* The BAuA data helps to identify the biocidal products used in plasters and mortars (if any).

In plasters and mortars secondary raw materials are also used as aggregates or additions. This has advantages in terms of sustainable use of resources. With regard to indoor air volatile emissions cannot occur. However, because of the *Waste Avoidance, Recovery and Disposal Act's* prohibition on dilution of pollutants through recycling, certain limitations on concentrations of harmful substances have to be respected.

3.2.3 Health Related Assessment Methods and Test Methods for Plasters, Mortars and Gypsum Boards

Emissions of VOC and SVOC (semi-volatile organic compounds) can be tested and assessed according to the *AgBB Evaluation Scheme* of the *Committee for Health-related Evaluation of Building Products* [AGBB 2005], which sets criteria for VOC emissions from building products suitable for indoor usage. The test methods used so far are prEN 13419 parts 1-3[23] [CEN 1999a;CEN 1999b;CEN 1999c] and ISO 16000-6 [ISO 2004b]. Formaldehyde emissions can also be tested according to EN 13419 part 1 or part 2, and analysed according to ISO 16000-3 [ISO 2004a].

There is yet no European test method for the assessment of radioactive radiation of construction products. In Germany, the methods *Gamma Spectrometric Determination*

[23] In 2006 the standard prEN 13419, Parts 1-3, has been conveyed into the standard EN ISO 16000, Parts 9 – 11: Indoor air. Determination of the emission of volatile organic compounds from building products and furnishing (Part 9 – Emission test chamber method; Part 10 – Emission test cell method; Part 11 – Sampling, storage of samples and preparation of test specimens).

of the Specific Activity of Radio Nuclides in Soil [BMU 2006], and *Gamma Spectrometric Determination of Selected Natural Radio Nuclides* [BMU 2000] are applied. A *Method for the Gamma Spectrometric Determination of the Specific Activity of Radio Nuclides in Construction Materials* is in the course of being published. The Austrian standard ÖN S 5200 [ÖN 1996] can be applied for the assessment.

3.3 Plasters, Mortars and Gypsum Boards: Substances of Content and Emissions

3.3.1 Contained Substances

Cement and lime-based systems include masonry mortars, plastering mortars, adhesives for tiles and screeds. The main binder is cement or lime. An alternative binder can be added. As for gypsum products, inorganic aggregates, additives and organic admixtures, as well as some organic additives are used.

Further product variants include **cementitious modified systems**, which contain organic binders such as synthetic dispersions or dispersion powder. This includes, for example, dispersion adhesives for tiles, modified screeds or products and systems for the protection and repair of concrete structures, like polymer cementitious concrete (PCC). Table 6 shows typical organic raw/source materials for dispersion modified mortar systems and cementitious factory-made mix mortar. For the latter the given materials are representative, according to manufacturers, for about 95 % of cementitious mortars on the market.

Table 6 – Typical organic raw materials/additions in cement- und lime bound mortar systems

Raw Materials/Admixtures	Usual Concentrations
In factory made mix mortar according to 998-1	
Water retainment agent: methylcellulose	up to 0,5 %; in all;
Air entraining agent: olefin sulfonate;	up to 0,1%; in many
Set-up agent: starch ether	up to 0,1 %, in some
Set-up agent: layered silicates	up to 0,1% , in some
Water repellent agents: sodium oleate or zinc stearate	up to 0,3 %, in all for exterior use
Bonding agent: dispersion powder: vinyl acetate, ethylene	up to 0,5%, in thin layered plastering; up to 3% in adhesives for tiles
In cementitious modified screeds according to EN 13813	
Dispersion powder on the basis of co-polymers of vinyl acetate/ vinyl versatate / ethenes	0,1 % („traditional“ screeds/quick screeds) up to about 3% (floor levelling compounds, partially self-flowing).
Cellulose ether: basis hydroxyethylcellulose respectively methyl hydroxyethyl cellulose	about 0,01 % – 0,2 %).
Defoaming agent: hydrocarbons/polyglycols on an inorganic carrier	about. 0,05%- 0,3%.
Accelerating/Retarding agent: calcium formiate, lithium carbonate, citrate etc.	0,05% - 0,25%.
Liquefying agent: melamine sulfonates, casein, naphthalene sulfonate, polycarboxylate etc.).	0,02% - 0,5%.

Raw Materials/Admixtures	Usual Concentrations
In cementitious modified adhesives for tiles according to EN 12004	
Dispersion powder on the basis of co-polymers of vinyl acetate/ ethane/vinyl versatate and eventually other monomers as methyl acrylate and styrene acetate	up to 4,5%.
Cellulose ethers: methylcellulose, partially modified, methylhydroxypropyl cellulose.	about 0,1% – 0,5%.
Starch ether	about 0,05% - 0,2%
Cellulose fibres on the basis of technical cellulose	about 0,3% - 0,7%
Accelerating/Retarding agents: calcium formiate, lithium carbonate, citrate etc.	0,1% – 3,0%

Source: [HILDEBRAND 2005]

The main component of **Gypsum products** is calcium sulphate, which acts as binder. Either natural gypsum or gypsum from combustion gas desulphurisation is used. In both cases, requirements for the content of toxic substances have to be complied with. For gypsum from combustion gas desulphurisation, the Association of the European Gypsum Industry, Eurogypsum has defined *Quality criteria and analysis methods* [EUROGYPSUM 2005].

Phosphoric gypsum may have an elevated radioactivity. Phosphoric gypsum is not used in construction according to information from the German Gypsum Industry Association (Bundesverband der Gipsindustrie e.V.); also for cost reasons, future use is not expected either. Table 7 shows two example formulations for gypsum plaster:

Table 7– Example formulation for gypsum plasters

Raw material	Concentration %
Light weight gypsum plaster, for machine application	
Plaster of Paris (beta-half hydrate)	75,0
Ground limestone (0,2-1 mm)	16,0
Perlite	4,0 (2-5)
Lime hydrate	3,0
Methyl cellulose (unmodified)	0,3
Starch ether	0,1 (0,05-0,5)
Tartaric acid	0,1
Gypsum based thin layer plaster	
Plaster of Paris	85,0
Ground limestone	8,0
Lime hydrate	3,5
Perlite	2,5
Methyl hydroxyethyl cellulose, modified	0,35
Hydroxypropylguar	0,11
Tartaric acid	0,080
Starch ether	0,030
Air entraining agent	0,020

Source: [GLATTHOR 2005b;GLATTHOR 2005a]

According to EN 520, gypsum plasterboards are produced by applying gypsum slurry on a paper liner and are dried in a thermal process. Among the components named in the table above, small amounts of polyglycolethersulfates as defoamer and silicone oils for impregnation for boards designed for use in damp locations, are typically also used. Gypsum plasterboards have been investigated by the *Institut für Baubiologie* (Institute for Building Biology) in Rosenheim. Test chamber measurements have not been carried out, but the content of VOC was determined. None of the tested VOC was detectable. This does not represent a final proof that no emissions may occur, but the drying step at a temperature of 110°C also contributes to expelling low boiling substances.

Calcium sulphate binders, calcium sulphate composite binder und calcium sulphate factory-made mix mortars for the production of screeds according to EN 13454-1 may contain, (besides inorganic additives as fillers), puzzolana, pigments and other organic admixtures, as well as resins as an additive.

A list of identified formulation components for mortars and plasters is given in Appendix D. As far as single substances are specified, information is given with regard to vapour pressure, molar mass, usual concentration in the product, toxicity and labelling as well as eventually existing LCI-values from the *AgBB Evaluation Scheme*.

3.3.2 Emissions

There are only a few published results on emission measurements for mineral and modified mineral plasters, mortars and gypsum boards. Commissioned by the *Swiss Federal Office on Energy*, test chamber measurements have shown no emissions for gypsum adhesive/filler and white plaster. [ZELLWEGER 1997]. Specific research has been conducted with regard to the emission behaviour of VOC for concrete. For concrete, only negligible emissions have been detected after 14 days, using different concrete admixtures. [BRAMESHUBER 2000].

The *Fraunhofer Institute for Building Physics* is currently conducting an extensive and systematic research project on cement and lime-based plastering/rendering and masonry mortars. The I*ndustry Association for Factory Mortars (Industrieverband Werkmörtel e.V.)* has commissioned the study as it acknowledged that pertinent research was lacking [BREUER 2005]. In this context, the possible generation of ammonia caused by the chemistry of the alkaline mortars was pointed out. It can neither be excluded that metal oxides catalyse a regeneration of organic compounds.

Organic admixtures are added to plasters and mortars in very low amounts. The question arose whether on a calculative basis any significant emissions can be expected at all. A simple calculative example gives evidence that even very low amounts of volatile compounds can be of significance:

Assumed is a room with a base area of 20 m^2 and a height of 2,30 m, on which a machinable lime-based plaster with a coat thickness of 10 mm is plastered on the walls and ceiling. About 770 kg of dry mix are needed for a plastering surface of 55 m^2 and assuming a productiveness of 14 kg/m^2 [QUICK-MIX 2005]. If you assume a fraction of 0,25 % volatile organic compounds, this would amount to a total of 1,9 kg of volatile substances introduced in the room. If you further assume a complete and homogenous release for the one-year period, this would result in an hourly emission of 0,22 g/h or about 5 mg/m^3/h. Obviously this calculation does not take real diffusion and emission behaviour into consideration. In reality, emissions are high in the beginning and will

stabilise after some weeks. However, the example makes clear that because of large surfaces even low concentrations of volatile compounds can be of significance.

On the other hand, it has to be emphasised that to all appearances the mineral systems considered here do not represent one of the regular sources for high indoor air emissions, simply because until now they have not been identified as a source in any publicly documented case when searching for the origins of high indoor air VOC concentrations. However, we recommend the inclusion of calculative considerations to assess, whether relevant emissions are at all possible, once emission patterns and volatility of used admixtures are better known.

For WT classification, it is indispensable to prove through representative emission measurements that none of the products in the product groups under consideration shows any critical emission. Further it is necessary to restrict the scope of product definitions in order to ensure that all products covered by the standard show low emissions. Without such representative measures, we cannot assess modified mineral systems. These are composed using not only organic admixtures but also organic binders. It is not yet clarified, whether modified mineral systems differ in their emission behaviour from that of not modified ones.

3.3.3 Proposals for Classification

The above-mentioned formulations show that mineral products contain organic components only as admixtures. Whether they contribute to VOC emissions depends firstly on volatility and secondly on the amounts used. Within the workshops, it was suggested that the organic admixtures used in plasters and mortars should be listed and assessed with the help of vapour pressure and molar mass, to see, whether they are likely to emit at all. From there, a positive list of admixtures could be generated. The list could be used as a primary criterion for the WT classification. The list could be integrated to the product definition in the standard. This would prevent products with deviating emission behaviour receiving the WT status.

A standard list of generally known substances contained in mineral mortar systems divided to a positive list (not indoor air relevant) and to a negative list (indoor air relevant) could cover 80-90% of the substances in use. Other „exotic“ compounds could be assessed for their indoor air significance on the basis of relevant criteria such as vapour pressure, boiling point, toxicity, etc. The Know-How of formulation represents capital of the manufacturers. Therefore, manufacturers see positive and negative lists understandably with scepticism. If such lists do not refer to single product groups but rather to several product groups at the same time, the company secret would remain *de facto* intact. This solution could raise the level of acceptance without reducing the functionality for the WT or WFT classification.

One difficulty, which remains to be resolved, concerns substances applied in different modifications, such as methylcellulose. It remains to be checked, whether such substances are indoor air relevant at all. For methylcellulose this is not the case, since it is not volatile. In addition, requirements should be defined regarding the purity of the raw materials used or the intermediate products generated. For example, methylhydroxycellulose could release ethylenglycol. In the next step, as a further criterion for WT classification, critical concentration thresholds in products could be determined, below which there is no indoor air relevance.

From a wider perspective, modified mineral systems should be looked at, as they also contain organic binders in addition to the organic admixtures. When using dispersion powders of co-polymers, the question of emissions of volatile aldehydes and residual monomers arises. According to information from the *Deutsche Bauchemie* for the last five years these emissions have not occurred any more, as manufacturers of polymer dispersions and dispersion powders have lowered the concentrations of residual monomers accordingly [GLÖCKNER 2005].

In this context, the option of defining a sum parameter for the admissible organic concentrations was discussed as a criterion for the WT classification. A maximum concentration of organic compounds has so far been defined as criterion for fire resistance class A 1 in the standards for mineral plasters and mortars. However, this solution does not seem feasible for judging emissions, as certain substances might lead to critical indoor air values already at very low concentrations. As an example chloromethylisothiazolinone (5-Chloro-2-methyl-2H-isothiazol-3-one) was given, whose LCI-value24 is defined at 1 µg/m3. However, if sum parameters are limited to critical substances or substance groups, it might represent a useful criterion for the classification as WT.

The radioactivity of the source materials used in the discussed product groups is generally low. In this regard, measurements have been carried out in the past and according to information from the manufacturers, sufficient data is available. From the point of view of the gypsum industry for example, nothing speaks against introducing a clause for the exclusion of radioactivity in the standards.

3.4 Organic Plasters: Substances of Content, Emissions and Proposals for the Classification

The term organic plasters covers a number of products with a large bandwidth of characteristics, intended uses and consequently formulations. Also concerning the binders used, there are many options. The following table shows one example of a formulation for an organic product for internal plastering.

Table 8– Exemplary formulation of an organic plastering product

Contained Substances	%
Water	13-15
Cellulose ether	0,2
Dispersing agent	0,1
Synthetic resin dispersion (50%)	6-8
In-can preservation	0,01-0,03
Titan dioxide	1-3
Silicate	5
Calcium carbonate	16

[24] LCI: Lowest concentration of interest. LCI are substance specific calculative values, which guide the assessment of construction products according to the AgBB approach. They substantiate the avoidance of health hazards by VOC/SVOC mixtures. The AgBB sets LCI-values based on consultation of industry and manufacturers' associations and publishes them in a list of LCI-values. However, emissions of substances without a defined LCI are also limited in the AgBB Evaluation Scheme.

Contained Substances	%
Marble powder	20
Marble grains	38
Defoamer	0,1-0,2
Additive (Processing time)	0,15

Source: Deutsche Amphibolin-Werke

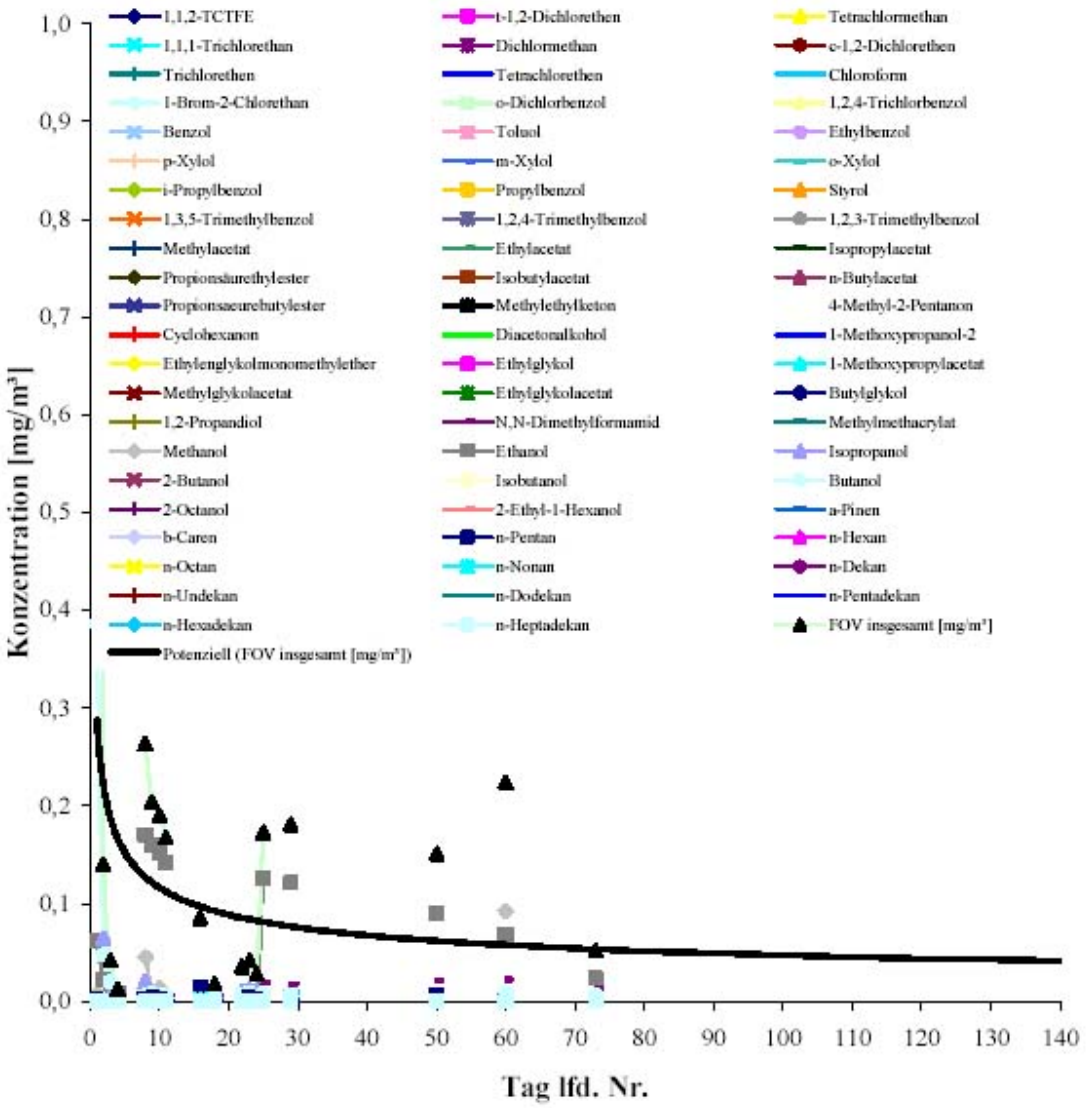
Organic plasters may contribute to indoor emissions much more than the competing mineral products, because of their more volatile contents. Health consciousness on behalf of users, appliers and producers has already contributed to lower emissions. A major part of the producers has already optimised their products with regard to emission behaviour. Therefore, organic plasters designed for indoor use show today mostly uncritical emission behaviour. A test chamber measurement carried out by the *Center for Humanities and Health Sciences of University Medicine Berlin* shows an organic plaster, whose emissions after 20 days already decrease below 100 µg/m^3 [LÜTH 1999].

Table 9 – Composition of organic plaster tested in test chamber measurement according to producer's information

Substance Group	% by weight	Specific Substance
Water	15,25	Urban water
Preservation agent	0,15	Less than 0,0015% of free formaldehyde
Film forming agent	0,15	Dimethylphthalate
Surfactant	0,10	Phosphate
Filler	78,00	Calcium carbonate, quartz sand, titanium dioxide, ground
Thickener 1	0,10	Cellulose
Thickener 2	0,10	Bentones
Binder	6,00	Polymer dispersion on the basis of vinyl acetate
Defoamer	0,15	Mineral oil defoamer

Source: [LÜTH 1999]

Figure 7 - Course of measured VOC-concentration of an organic plaster



Source: [LÜTH 1999]

That organic plasters can be produced in a way to achieve uncritical emission levels is also shown by test chamber measurements conducted by the *Federal Institute for Materials Research and Testing* (BAM) on ready-to-use organic plasters. Two of the tested plasters show an inconspicuous emission behaviour. On the other hand, there are also products on the market – at least in the segment of do-it-yourself ready-to-use plasters - which also show high emissions after 28 days and in one case even the carcinogenic benzene was emitted [HORN 2005].

Ready-to-use products cannot be considered representative for the market of commercial and professionally used products. Furthermore, it is important to distinguish between products for external and for internal use, as only the latter ones are optimised with regard to advantageous emission behaviour.

On the other hand, it is evidently not possible to classify organic plasters as WT for the time being. This is unfortunate because producers who in the past have invested in low emitting products and have brought them onto the market now have to carry testing burdens, which should be the responsibility of those competitors who without regard produce qualitatively inferior products. In the end, organic plasters are an example,

showing that standards defined vaguely with regard to health and environment may inhibit quality-oriented innovation.

In the case of organic plasters, the integration of emission related tests in the European standards could also be seen as a way of differentiating qualitatively superior products from inferior ones and thus creating a market advantage for innovative producers. Given the relatively high testing costs at the moment for test chamber measurements and their duration, as well as the current lack of faster tests, the producers' interest in classifying generally low emitting product lines as WT is understandable.

Participants of the project workshops discussed solutions, which would allow WT or WFT classification of low emitting organic plasters for interior use. One option would be to define so-called formulation windows, which define maximum values for certain substance groups and exclude certain critical substances, for example, carcinogenic ones or substances to which no LCI-Value has been attributed within the AgBB scheme.

For the substantiation of such an approach, as a first step the producers themselves are required to use their formulation knowledge to develop hypotheses for suitable formulation windows and to prove correlation with advantageous emission behaviour. Even if correlations between formulation windows and emissions do not seem feasible, formulation windows would be a step towards minimisation of the testing burden. They would enable tests on broad ranges of product groups and thus help avoiding tests on single products.

3.5 Legal Requirements Related to Waste Law for Secondary Construction Materials Used in Plasters and Mortars

The harmonised standard *EN 13139 – Aggregates for Mortars* defines requirements for aggregates and fillers for masonry mortars, screed materials, plastering mortars, rendering mortars and special mortars. The harmonised standard *EN 13055-1 – Lightweight aggregates - Part 1: Lightweight aggregates for concrete, mortar and grout* defines the respective requirements for concrete and mortar in all application fields, excluding cementitious components and non-inert fillers for mortar like fly ash. As all European standards for aggregates, EN 13139 applies for natural, manufactured and recycled materials and mixtures, without specifying any quality requirements related to waste law. Formally, Annex ZA of the standards refers to the national regulations.

The product standards for mortars and plasters specifying their characteristics do not take into account the standard for aggregates, but indicate only in general terms that aggregates are used. At the moment national requirements concerning the use of secondary raw materials in plasters and mortars are specified by the following technical standards, which, however, are not covered by a mandate under the CPD.

Standard	Title
EN 13914-1 2005	Design, preparation and application of external rendering and internal plastering - Part 1: External rendering
EN 13914-2 2005	Design, preparation and application of external rendering and internal plastering - Part 2: Internal plastering
DIN V 20000-412 2004	Application of building products in structures - Part 412: Rules for the application of masonry mortar according DIN EN 998-2:2003-09

The national application standard DIN V 20000-412 for mortars limits the EN 13139 to the effect that secondary raw materials allowed as aggregates for masonry mortars are restricted to crystalline air-cooled blast furnace slag, granulated blast furnace slag according to DIN 4301, and melting chamber granulate. With regard to EN 13055-1 the allowed recycled lightweight aggregates are restricted to expanded glass, vermiculite, bloated perlite, expanded shale, expanded clay, sintered hard coal fly ash pellets, foamed slag according to DIN 4301 and foundry sand. The application standard *DIN V 20000-412 Rules for the application of masonry mortar* complies with waste law related requirements by taking into account *DIN V 20000-104 „Application of construction products in construction engineering, Part 104, Light aggregates according to EN 13055-1*"

As a result of the harmonisation required by the CPD the German requirements on secondary materials need to be integrated into the next generation of harmonised standards for aggregates e.g. as a level or class. The requirements established in Germany for the application of mortars are shown below. Corresponding requirements should be integrated in the respective European standards.

Expanded Glass

Expanded glass according to EN 13139 may be used in concrete only when not produced from environmentally dubious recycling glass such as lead glass.

Sintered Coal Fly Ash Pellets and Furnace Sand

Sintered coal fly ash pellets and furnace sand (furnace bottom ash) according to EN 13055-1 may be used in mortars only when coming from combustion plants fuelled with anthracite or hard coal.

For the production of fly ash and furnace sand, allowed co-combustion materials are lignite up to 10 % by weight and municipal sewage sludge up to 5 % per weight (dry matter), referred to the dry mass of the coal.

For the sewage sludge, it has to be shown, that the following limit values (mg per kg sludge dry matter) are complied with:

-Lead ≤ 900
-Cadmium ≤ 10
-Chromium ≤ 900
-Copper ≤ 800
-Nickel ≤ 200
-Mercury ≤ 8
-Zinc ≤ 2500

Moreover the content of phosphate, expressed as P_2O_5, may not exceed 25% per weight of the ash content of the sewage sludge.
If these requirements are not complied with, fly ash pellets need a national technical approval.

In a comparable way, requirements for crystalline lump blast furnace slag, granulated blast furnace slag and melting chamber granulate have to be integrated [LAGA 1998] in the standards for aggregates. Finally, we refer to the report of the *UBA* [EHRNSPERGER 2005], which recommends examining the content and the leachate of manufactured aggregates for regulated parameters.

3.6 Plasters, Mortars and Gypsum Boards for Interior Use: Suitability as WT or WFT

Representatives of industry and authorities involved in the workshops evaluated **mineral plasters and mortars as well as gypsum boards** as unproblematic with regard to VOC emissions, formaldehyde emission and radioactivity and therefore as suitable for the WT classification for indoor air. This should be true based on the current state of knowledge, also for part of the modified mineral systems.

Nevertheless, for the time being indisputable evidence is lacking. This is true for all products on the market. Looking only generally at the substances used does not allow for a WT classification, because:

- All products are produced using organic components.
- Relatively small amount of organic components may also cause significant emissions.
- Because the product definitions are open with regard to the substances used, the standards do not give any security that only such organic substances are used - or are used in such low concentrations - that no critical emissions occur and that future innovative products do not significantly deviate from the assessed ones.

However, WT classification of mineral plasters, mortars and gypsum with regard to indoor use should be possible on the condition that:

- Product definitions will be specified with regard to the raw material groups used and to potentially critical substance groups.

  It is not desirable that substance related definitions are too narrow; as they would contradict the performance principle prescribed within the CPD and could hamper the development of new formulations. These definitions should therefore be limited to parameters relevant for the emission behaviour. (However, in principle, WT or WFT products can be only well-known products, as for innovative products the suitability for WT/WFT would have to be proven first). The product definitions related to WT could be specified in the context of the WT classification by the EC expert group, but a more rational way, however, would be to do so in the revision of the standards of the second generation.
- Usual and well-tried organic admixtures and additives, which do not or only insignificantly lead to emissions to indoor air, are compiled in a positive list. Undesired organic substances, such as carcinogens, are compiled in a negative list. Positive and negative listings can be taken into account for the classification. These lists should, if possible, be kept product group comprehensive. Non-volatility represents the main criterion for inclusion into the positive list. Information on the required purity of used substances should also be given.
- Scientifically based studies prove that product groups on the market in their entirety do not cause emissions exceeding the criteria of the AgBB-Scheme. The research needs to be carried out for product groups complying with the WT product definitions. Tests on “worst-case” formulations prove that emission criteria can also be complied with in the case of variations during manufacture.
- From the results of above-mentioned studies, maximum concentration values for potentially volatile substances can be derived for the purpose of drawing a dividing line for products not conforming to WT criteria.

- As far as results from non-harmonised test methods are presented in the application for a WT classification, these should be accepted only when compliance with target values is reliable. If results are only slightly lower than the target values, a WFT classification on the basis of harmonised test standards is recommended. However, a general factor determining reliable compliance cannot be defined. A suitable factor would reflect the bandwidth of products covered in the product group, while considering possible variations during manufacture.
- For the use of aggregates from secondary sources in plasters and mortars, current (and future) national requirements with regard to waste law have to be observed. This demands in particular the revision of the harmonised standards for aggregates, which should include corresponding requirements and define levels or classes corresponding to the nationally required levels and which can then be taken into account by the national provisions.

Organic plasters cannot be classified based on the current state of knowledge, as a part of the products on the market show critical emission behaviour. An option might be the identification of „formulation windows“, for example, by defining maximum concentrations for critical substance groups and positive and / or negative lists for certain substance groups. Because of the vast number of formulations and because of their confidentiality, the first step is up to the producers to develop cut-off-criteria on the basis of their formulation knowledge and to draw a dividing line for „black sheep“. Organic plasters are an example showing that standards too vague on health and environmental requirements can hamper quality-oriented innovation.

Characterisation tests for products with indoor air relevance involve a relatively high effort, as test chamber measurements are time consuming and costly. As the products considered for the main part do have a low relevance with regard to health hazards, the objective should be to minimise the effort required for evidence. General options to rationalise the classification procedure are:

- **Avoid or minimise testing efforts by specifying substance related product definitions.** In the end it is up to the producers in the CEN working groups to decide in which cases open product definitions offer an advantage against more onerous health and environmental testing, and in which cases precise product definitions contribute to minimising testing efforts in a pragmatic way.
- **Distribute costs for research among the interested parties.** The *Industry Association for Factory Made Mortars* is acting as a pioneer by commissioning cross-sectional research on the emission and release behaviour of mineral plasters and mortars. We recommend that for carrying out such research projects advisory boards are set up, involving representatives of authorities to ensure that all interested parties accept research design, assessment and results.
- The system of technical standards is rather fragmented (Many different standards for products being very similar with regard to the materials applied). **Minimising classification efforts should be envisaged by cross-referencing assessments already carried out for product groups with comparable substance and material composition.**

3.7 Draft for a Product Definition for WT Classification: Example of Gypsum Plaster Boards According to EN 520

Gypsum plasterboards are manufactured using gypsum binder according to EN 13454-1. Gypsum from combustion gas desulphurisation has to comply with the quality criteria of Eurogypsum (http://www.eurogypsum.org/Pages/BROCHGYPSUM.pdf). Phosphoric gypsum is not used to exclude the possibility of radioactive radiation.

As additives, only inorganic fillers, pigments, lime (< 5 %) as well as organic or inorganic fibres are used.

The used paper liners are not treated with biocides.

As aggregates natural materials, such as sand or ground limestone, are used. The following manufactured aggregates may also be used: perlite, vermiculate, styrofoam.

Admixtures used include retarding, liquefying or air entraining agents. Only those admixtures are applied which are comprised in the "positive list for plasters and mortars".

The boards pass through a thermal drying process where a drying temperature of 110°C is maintained for at least 30 minutes.

4 Products for Road Construction

4.1 Product Groups: Use and Amounts

Roads have to meet high requirements with regard to load carrying capacity, surface conditions and durability. This is achieved – according to the intensity of use – by a structure of courses, where the courses have different functions and are made of different materials.

The first layer to be imported on the roadbed is the selected sub-grade. This is usually a gravel type material as well as the next layer, the sub-base. The final layer of a road is the base course consisting normally of gravel or crushed stone, sometimes Portland cement. The surface wearing course consists most commonly of asphalt.

For the protection of soil and groundwater, the permeability of the construction method is the decisive characteristic with regard to the input of potentially contaminated seepage water. Water impermeable construction methods include carriageways with bitumen or cement bound wearing courses or with a wearing course of sett paving deck or a slabstone paving with sealed joints. The partially permeable construction methods include sett paving or slabstone paving with unsealed joints. Permeable construction methods include unbound wearing and base courses. [FGSV 2001a].

The location of the construction further plays an important role for the protection of the groundwater. Permeability, thickness and formation of the stratum above the groundwater determine the protective effect. Inside water protection areas, wellhead protection areas and flood protection areas, restrictions with regard to construction measures and used materials are to be observed. Roads – apart of the small percentage of private roads - are erected by public awarding authorities. According to the type of road this may be the Federation, the *Länder* or the municipalities.

The most important product group in terms of quantity are aggregates. They are used for the preparation of asphalt, concrete, hydraulically bound base courses and unbound base courses and anti-frost courses. Aggregates are classified for technical reasons primarily according to particle size and particle density. Aggregates are applied from natural and from secondary sources. The natural aggregates include sand, gravel and crushed rock: the secondary aggregates include materials such as iron and steel slags, fly ash, slags from thermal processes and demolition rubble (i.e., recycled building material).

Table 10 gives an overview of the amounts consumed per year in Germany. As different sources were used for the compilation, not all data refer to the same year. The data was not adapted to a common base year, because it was assumed that order of magnitudes does not change from one year to the next and because in the current context it is only necessary to have an estimate of the general market share. Within the project *Amounts, Whereabouts and Quality of Mineral Waste* commissioned by the *Federal Environmental Agency*, data and ways of recovery of mineral waste are being determined, including recovery in the field of road construction [DEHOUST 2005]. The report of the project will be available shortly.

Table 10– Yearly generated and/or used construction materials in road construction

Product	Generated	Used in Road Con-struction	Year	Source/Comment
Natural Raw Materials				
		Mio. m^3		
Aggregates				
Crushed rock	190	150	2002	[KWTB 2003], Share of road construction estimated
Sand and gravel	350	105	2002	[BKS 2003]
Concrete*				
In-situ concrete		151	2001	[ROSENKRANZ 2003] Civil engineering total
Precast concrete products		67	2001	[ROSENKRANZ 2003] Civil engineering total
Mortar		6	2001	[ROSENKRANZ 2003] Civil engineering total
Binders for hydraulically bound courses		11	2001	[ROSENKRANZ 2003] Civil engineering total
Ashlar		33	2001	[ROSENKRANZ 2003] Civil engineering total
Bricks		2	2001	[ROSENKRANZ 2003] Civil engineering total
	Mio. t	Mio. t		
Asphalt*		50	2002	[DAV 2003]
Secondary Raw Materials				
Recovered asphalt		**ca.** 12	2002	Estimate Öko-Institut
Demolition rubble	54	38	2000	[KWTB 2003]
Demolition rubble from roads (bitumen bound and tar containing)	22	19	2000	[KWTB 2003]
Waste from construction sites	12	1	2000	[KWTB 2003]
Iron and steel slags				
Blastfurnace slags (including granulated slags)	7,2	2,4	2002	[MERKEL 2003a]
Steel slag	6	3,5	2002	[MERKEL 2003a]
Slags from secondary metallurgy	0,5-1		2002	[MERKEL 2003b] Used primarily in earthworks
Non ferrous slags				
Copper slags	0,7	0,35	2002	[MERKEL 2003b] Use mainly in hydraulic engineering
Mine waste heaps from copper shale mining		0,4	1999	[VOß 2001]
Other slags (Pb, Zn)	0,3	0,3	2002	[MERKEL 2003b]
Melting chamber granulate	2			[VOM BERG 2003]
Fly ash from hard coal	4	1	2002	[VOM BERG 2003] 3 Mio. t as additive for concrete. 0,5 Mio. t for earthwork, 0,5 t for cement bound base courses

Product	Generated	Used in Road Con-struction	Year	Source/Comment
Fly ash from lignite	7		1999	[VOM BERG 2003;MERKEL 2003b] Used mainly for soil amelioration
Bottom ash	0,5		2002	[VOM BERG 2003] small shares are used in unbound courses with moderate requirements to stability (e.g. bicycle tracks)
Bottom ash from fluidised bed incineration (hard coal and lignite)	0,6		1999	[KRASS 2002]
Ash from domestic waste incineration	3,3	2,6	2002	[JOHNKE 2003]
Foundry residues				
Foundry sand residue	1,4	0,2	1999	[KRASS 2002]
Foundry cupola slag	0,04	0,03	1999	[KRASS 2002]
* including aggregates				

4.2 Technical Regulations for Road Construction and Environment Related Requirements

4.2.1 Structure of the Technical Regulations for Road Construction

The technical rules for road construction are developed in the working groups of the *Roads and Transportation Research Association* (German designation: FGSV). Nearly 90 technical committees, with about 140 working groups and associated ad-hoc-groups, work on the subjects of nine fields. There are 15 joint committees with the *German Institute for Standardisation* (DIN), which act as mirror committees for the technical committees of CEN [FGSV 2002a]. Working groups developing the technical regulations considered here come from the working areas „*Mineral Matters in Road Construction*“, „*Asphalt Roads* “, „*Concrete Roads“* and „*Earthwork and Groundwork*“. In the various working groups, representatives of the interested parties are involved. Representatives of the *UBA* are involved in working groups in the areas of *Mineral Matters in Road Construction*, *Asphalt Road*s and *Earth- and Groundwork* .

The national reference point for technical regulations for road construction is *Contracting Regulations for Award of Public Work Contracts – Part C (German designation: VOB)[DIN 2002]* which contains regulations for technical application and use. Additional technical terms of contract (German designation: ZTV) contain supplementary regulations.

Requirements for construction materials are defined in technical terms of delivery (German designation: TL), testing methods are described in technical terms of testing (German designation: TP). Guidelines, fact sheets, instructions and notes complete the body of regulations.

European standards for road construction products are mainly developed in the working groups of the following technical committees: *CEN/TC 154 Aggregates*, *CEN/TC 227 Road Materials* and *CEN/TC 104 Concrete and related products*.

These product groups are covered by the following mandates. The appendix C.2 lists the mandates with the families and sub-families that are relevant in the project.

Mandate M/124 Road Construction Products

Mandate M/125 Aggregates

Mandate M/128 Products Related to Concrete, Mortar and Grout

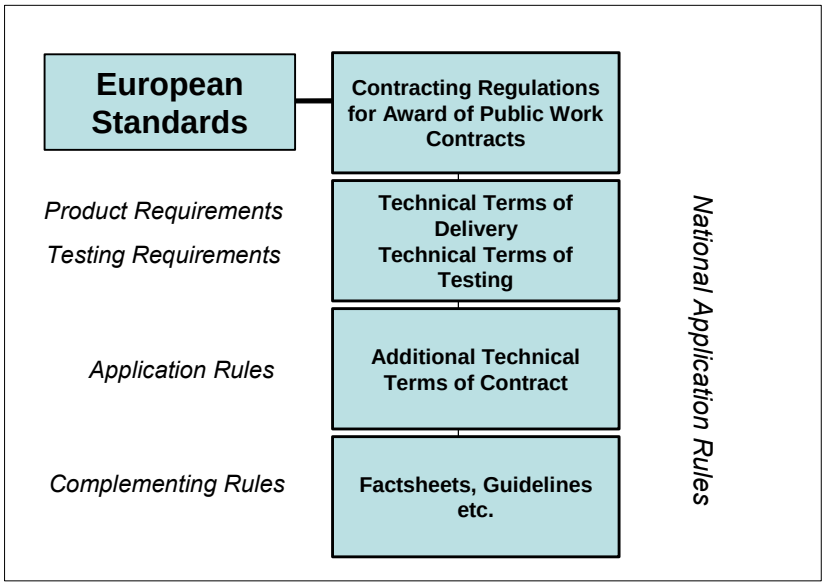
Public purchasers have to consider European standards before national standards according to the Directive 2004/18/EC[25]. This applies to mandated as well as to non-mandated standards. In the German provisions for the award of public work contracts (German designation: VOB Part C[26]) the harmonised European standards were taken onboard from 2004 [DIN 2002], while the corresponding national standards have been withdrawn. The CEN/TC 154 working groups have succeeded in developing mandated product standards in a scheduled manner enabling their introduction as a „package". This has made the respective adaptation of the national regulations easier.

As far as European standards allow for levels and classes, national requirements can be addressed in national appendices or in additional national provisions. Figure 8 shows the national system of road construction regulations implemented for the first time in 2004.

[25] DIRECTIVE 2004/18/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts. Official Journal L 134, 30/04/2004 P. 114 – 240.

[26] The "VOB" is the standard reference work for the award of construction contracts in Germany in both the public and the private domain. The VOB/A implements the EU Directives on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts. VOB/B contains the general conditions of contract relating to execution. Part C includes general specifications.

Figure 8 – System of Road Construction Regulations



Source: Öko-Institut modified according to [WEßELBORG 2003]

The here relevant technical terms of delivery in force are:

- Technical Terms of Delivery for aggregates in road construction (German designation: TL Gestein-StB 04) [FGSV 2004a]
- Technical Terms of Delivery for construction material mixtures and soil for the construction of binderless layers in road construction (German designation: TL SoB-StB 04) [FGSV 2004b]
- Technical Terms of Delivery for construction products used for the construction of sett paving and tile work (German designation: TL Pflaster-StB 06) [FGSV 2006a]
- Technical Terms of Delivery for asphalt in road construction (TL G Asphalt-StB 01) [FGSV 2005]
- Technical Terms of Delivery for construction materials and material mixtures for base courses with hydraulic binders and concrete surfacing (German Designation: TL Beton - StB 06) [FGSV 2006b]

These technical terms contain environmental requirements for the use of secondary construction materials.

4.2.2 Product Standards Proposed as Candidates for WT Classification

In the first workshops concerning road construction products, a number of product groups were discussed as being suitable for WT or WFT classification.

Table 11 shows the most important standards for the chosen product groups. Secondary construction materials are not covered in separate standards but included in the standards for aggregates and, as in the case of fly ash, in standards for hydraulic binders or additives.

- Natural aggregates (Sand, gravel and crushed rock)
- Concrete
- Asphalt
- Hydraulically bound mixtures
- Secondary construction materials such as fly ash, melting chamber granulates and iron and steel slags.

Table 11 – Product standards for road construction products proposed as WT or WFT

EN	Title	TC
Aggregates		
12620	Aggregates for concrete	154
13043	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas	154
13055-1	Lightweight aggregates – Part 1: Lightweight aggregates for concrete, mortar and grout	154
13055-2	Lightweight aggregates - Part 2: Lightweight aggregates for bituminous mixtures and surface treatments and for unbound and bound applications excluding concrete, mortar and grout	154
13242	Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction	154
13450	Aggregates for railway ballast	154
13383-1	Armourstone - Part 1: Specification	154
Concrete		
206-1	Concrete - Part 1: Specifications, performance, production and conformity	104
13877-1	Concrete pavements - Part 1: Materials	227
Asphalt		
13108-1	Bituminous mixtures - Material specifications - Part 1: Asphalt concrete	227
13108-2	Bituminous mixtures - Material specifications - Part 2: Asphalt concrete for very thin layers	227
13108-3	Bituminous mixtures - Material specification - Part 3: Soft asphalt	227
13108-4	Bituminous mixtures - Material specification - Part 4: Hot rolled asphalt	227
13108-5	Bituminous mixtures - Material specifications - Part 5: Stone mastic asphalt	227
13108-6	Bituminous mixtures - Material specifications - Part 6: Mastic asphalt	227
13108-7	Bituminous mixtures - Material specifications - Part 7: Porous asphalt (PA)	227
13108-8	Bituminous mixtures - Material specifications - Part 8: Reclaimed asphalt	227

4.2.3 Environmental Requirements for Road Construction Products

The European standards for road construction products, as most of the other construction products' standards do not include so far any specific environmental requirements. The national regulations at the site of use are applied.

According to § 3 of the *Federal Highway Act (German designation: FStrG)* the body responsible for the burden of road construction has to consider requirements regarding environmental protection. Requirements on environmental compatibility derive from water and soil protection law. Furthermore, chemical law, immission protection law and radiation protection law can also be of importance. Concerning the use of secondary raw materials, requirements of the Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal must be followed.

Environmental requirements for the use of secondary construction materials are specified in *LAGA-Communication 20 - Requirements for Re-use/Utilization of Mineral Residues/Wastes – Technical Rules* (LAGA-Rules) of the Working Group of the *Länder* on Waste Issues (German designation: LAGA) [LAGA 1998]. The *LAGA-Rules* do not cover all secondary materials used in road construction. Recently the *Technical Rules for Soil [LAGA 2004]* have been revised. These include allocation values for recovered soil materials.

The regulations for road construction implement the requirements of the *LAGA-Rules* in the *Technical Terms of Delivery for Aggregates in Road Construction* [FGSV 2004a]. The Guidelines *for the environmentally compatible use of industrial by-products and recycled construction materials in road construction* (German designation: RuA-StB 2001) specify which construction method is permissible with regard to water permeability and in which way the protective effect of the soil subgrade at the site of a construction measure is to be considered [FGSV 2001a]. Requirements for water protection areas are laid down in the *Guidelines for Constructional Measures on Roads in Water Protection Areas* (German designation: RiStWaG) [FGSV 2002c].

As environmental requirements have been partially included into the regulations of road construction before the publishing of the LAGA-Rules, not all of them correspond to current requirements. This is in particular true for the derivation and assessment concept of RuA-StB 2001. Therefore, environmental requirements in the regulations of road construction are currently revised.

The *Principles of Pre-emptive Groundwater Protection with Waste Recycling and the Use of Products (GAP-Report)* of the Working Group of the *Länder on Water Issues* [LAWA 2002] specify uniform threshold of insignificance values (TоI) for maximum concentrations of dangerous substances in groundwater. However, the implementation of binding material and product related application rules with material related allocation values is still pending. The *GAP-Report* and the *TоI-Values* represent the basis for a transparent and scientifically based implementation of the legal requirements of precautionary soil and water protection.

As a consequence, at the present it cannot be conclusively assessed in all cases whether a road construction product can be classified as WT, because in some cases unequivocal reference values are still lacking. However, the *GAP-Report* makes clear

that from the point of view of soil and water protection, it does not matter whether construction products are produced from primary or secondary materials. The critical factor is, whether T*oI-Values* are complied with at the point of compliance.

As far as it was helpful for orientation in the current context *ToI-Values* as well as allocation values from published technical rules were considered. This obviously does not mean to anticipate pending regulatory decisions. Rather, it means to give evidence to open questions arising for WT classification of road construction products.

The *Principles for Soil and Water* of the *DIBt* [DIBT 2006b] do not have formal validity for road construction products. However, the named criteria represent an assessment standard for all construction products in contact with the soil, therefore implicitly including road construction products.

4.2.4 Assessment Methods and Testing Methods for the Environmental Safety of Road Construction Products

For the protection of groundwater and the soil, substance emissions actually occurring from roads and resulting concentrations are of importance. Ideally, testing methods should reflect both short and long-term release behaviour of secondary construction materials and products and the as-is concentrations at the point of compliance. In addition, they should deliver quick and reliable results, be practical and cost efficient and give reproducible results for different materials.

The currently most commonly used test methods and the applied testing values represent pragmatic conventions, which may also lead to over- or underestimating actually occurring concentrations. These methods are, however, simply applicable in practice. CEN/TC 154 *Aggregates* developed the test method EN 1774 *Tests for chemical properties of aggregates*, following the trough method developed by FGSV [FGSV 1999b], which is appropriate for routine testing. Studies on the environmental safety of recycled construction materials under as-is application conditions show that the leachate obtained by shake test according to DEV S4 [DIN 1984] is quite appropriate for the description of material characteristics. For the prognosis of initially occurring concentrations in seepage water, other methods might be more precise, such as the (unsaturated) percolation method of FGSV. However, this method is also more complex and time-consuming. Studies show that because of the lower leachate/solid matter ratio, initial concentrations might be higher than in the leachate, according to DEV S4; considering water/solid matter ratio the leachate might produce higher concentrations for heavy metals, slightly higher ones for sulphate and lower ones for chloride [GOETZ 1990].

Within the joint project "*Seepage Water Prognosis"* commissioned by the *Federal Ministry of Education and Research* scientifically based methodology and practical procedures for such a prognosis have been developed. Seepage water prognosis is defined as an estimate of the contaminant input into the groundwater (the transition area between the unsaturated and the saturated zone) via infiltrated water at a specific site. The projects were finished in 2005 [EBERLE 2003], but the report is not available yet. In the context of *LAGA-Rules* leachate test methods based on DEV S4 will be used for the seepage water prognosis, as they represent well-tried methods [LEUCHS 2003] and because they have been determined as binding for the allocation of waste to landfills.

4.3 Road Construction Products – Suitability as WT

For the WT classification, it is of particular interest, which construction methods are water permeable, partially permeable and impermeable. Impermeable construction methods are those with asphalt wearing course, concrete deck and sett paving and slabstone paving with sealed joints.

4.3.1 Natural Aggregates

Natural mineral materials used in road construction are crushed rock, gravel and sand. Based on their particle density they are included into the group of normal weight aggregates. (Particle density of crushed gravel: 2.600–2.750 kg/m3, rounded gravel about 2.550–2.750 kg/m3, quartzite sandstone 2.600–2.750 kg/m3).

Standards for aggregates no longer use the terms “sand” and “gravel”, since aggregates are now classified using particle size fractions. Geological provenience does not play a role; they are differentiated with the help of a number of physical and chemical parameters.

Table 12 shows the types of rock used in road construction as they are listed by the Technical Rules for Aggregates in Road Construction [FGSV 2004a].

Table 12– Rock according to Annex A of TL Gestein-StB 2004

1	Granite, Granodiorite, Syenite
2	Diorite, Gabbro
3	Rhyolithe, Rhyodacite, Trachyte, Phonolithe, Microdiorite, Andesite
4	Basalt, Melaphyre
5	Scoriaceous lava
6	Foamed lava
7	Diabase
8	Limestone, Dolomitic limestone
9	Greywacke, Quartzite, Quartz gangue, Quartz sandstones
10	Gneiss, Granulite, Amphibolite, Serpentinite
11	Gravel, crushed
12	Gravel, round

Natural minerals have different concentrations of trace elements according to their provenience. The trace element concentrations have had little or no part to play within the discussion on environmental safety of construction products produced from natural minerals. With the *GAP-Report,* concentrations of trace elements come into focus insofar as there is no explicit differentiation between primary and secondary construction materials with regard to soil and water protection. The critical factor is only whether *Tol-Values* are complied with at the point of compliance. The *DIBt* has also suggested a general discussion on this issue to clarify whether additional requirements would support the objective of environmental protection. [EHRNSPERGER 2005].

As it can be assumed that natural aggregates remain chemically stable in concrete and asphalt, the crucial question concerning environmental safety according to the *Principles for Soil and Groundwater* is the performance of aggregates used in water perme-

able construction methods. This includes, for example, unbound wearings and base wearings or beddings under courses, under sett-pavings and refillings without water impermeable covering.

The following table shows the bandwidth of selected trace element concentrations in German rocks as it has been published by the *Federal Institute for Geosciences and Natural Resources (German designation: BGR)* in 1998. Overall 5300 records have been evaluated. In the following, the 50 and the 97,5-percentile[27] are shown [MEDERER 1998]:

Table 13 - Rocks – Distribution of inorganic elements (mg/kg)

Element	**Quartzite**		**Lime stone**		**Granite**		**Basalt, Diabase, Gabbro**		**Greywacke**	
Percentile	*50*	*97,5*	*50*	*97,5*	*50*	*97,5*	*50*	*97,5*	*50*	*97,5*
As	5	42	<5	28	8	49	<5	25	9	41
Cd	0,01	1	0,04	0,5			0,14	0,8		
Cr	26	229	7	35	8	136	215	654	58	102
Cu	<10	85	13	87	<10	46	44	97	17	78
Hg	0,008	0,1	0,005	0,1			0,09	0,1		
Ni	<7	73	<7	21	<7	48	91	362	<7	42
Pb	<10	70	<10	186	18	53	<10	69	41	228
Tl	<0,1	1	0,06	1,8			0,36	0,36		
Zn	11	11	13	218	55	122	102	293	61	146

Source: [MEDERER 1998]

No legal requirements exist regarding the concentrations of heavy metals in natural rock. Only when they are recycled do they have to comply with the allocation values of the *LAGA-Rules*. For the purpose of orientation, the values shown in Table 12 were compared with the allocation values of the *Technical Rules for Soil*[28] [LAGA 2004]. Some of the 97,5 percentiles slightly exceed the allocation values Z1 of the *Technical Rules for Soil*, such as the concentration of arsenic of granite of 49 mg/kg exceeds the Z1- allocation value of 45 mg/kg. For the basalt group the nickel value by far exceeds

[27] The percentile 50 represents the values, which is complied with by half of the considered samples, the Percentile 97,5 represents the value, which is complied with by 97,5% of the samples.

[28] The LAGA-Rule M20 and the Technical Rule Soil define allocation values for the use or disposal of materials. Concentrations below the allocation value Z 0 allow for unrestricted use in soil-like uses (water permeable construction method). Below allocation value Z 1 restricted open use (water permeable construction) is conceivable. The class Z 1 is further divided into Z 1.1 (apply normally) and higher Z 1.2 values (possible in areas with favourable hydrogeological conditions) The allocation value Z 2 sets the limit for restricted use with defined technical safety measures (water impermeable construction method). Beyond the allocation value Z 2 materials have to be disposed in landfill sites.

the Z1 allocation value. However, an interpretation concerning safety for the environment cannot be derived from this data.

Studies on the leaching behaviour of aggregates practically do not exist. An exception is a study from 1990 by the *Institute for Pedology of the University of Hamburg*. Within the study, 31 aggregates from natural and secondary sources were analysed. Table 14 shows a synopsis of the results, obtained according to DEV S4 ([DIN 1984]. For the detailed conditions and complete results of the study, we refer to the final report of the University of Hamburg [GOETZ 1990].

Table 14 – Concentrations in solid matter and leachate values (DEV S4) of selected rock

Parameter	Unit	Basalt	Diabase	Granite	Grey-wacke	Mela-phyre	Scot. Granite	Lime-stone	Devon. Lime	Juras. Lime
Concentration Solid Matter										
As	mg/kg	11	21	2,8	8,6	5,1	9	9	13	4
Cd	mg/kg	0,22	0,08	0,16	0,24	0,08	0,15	0,6	0,08	0,35
Cr	mg/kg	294	591	31	74	213	62	2,7	16	14
Cu	mg/kg	168	104	87	42	286	67	65	206	24
Ni	mg/kg	175	383	17	27	61	16	13	12	22
Pb	mg/kg	13	8,8	70	46	8,1	38	59	13	23
Zn	mg/kg	282	317	166	294	62	75	132	64	129
Concentration Leachate (DEV S4)										
pH		8,9	9,1	8,5	8,2	8,1	8,4	8,9	9	8,4
Cl	mg/l	0,6	9,9	0,3	4,4	2,3	0,7	1,5	1	1,3
SO4	mg/l	2,1	6,9	2,2	3,7	3,2	14	8	4,3	3,7
As	µg/l	35	35	31	31	30	34	26	21	23
Cd	µg/l	nd	nd	nd	nd	nd	1,2	nd	Nd	nd
Cr	µg/l	6	8	7	6	6	6	nt	7	6
Cu	µg/l	6	5	4	15	9	10	7	6	5
Ni	µg/l	nd	nd	nd	nd	5	Nd	nd	Nd	nd
Pb	µg/l	nd	nd	nd	nd	7	Nd	nd	Nd	nd
Zn	µg/l	19	26	38	21	83	11	4	64	100
nd = not detectable										

Source: [GOETZ 1990]

All leachate values excluding the ones for arsenic lie under the Z 0 values of the *Technical Rules for Soil*. The values for arsenic all exceed the Z 1.2[29] value of 20 µg/l. The threshold of insignificance value for arsenic is 10 µg/l. In the workshops, the participants assumed that the high values might derive from a systematic mistake in the analysis of arsenic. However, this cannot be verified with the help of the available research report. It has to be stressed that natural aggregates do not formally come within the scope of the *Technical Rules for Soil.* The according values were only used to get an orienting estimate for WT classification.

[29] Class Z 1 is subdivided in class Z 1.1. and Z 1.2. Generally, Z 1.1 allocation values are applied. Beyond Z 1.1 material complying with Z 1.2 allococation values can be used, if in the specific case the hydrogeological conditions are advantegeous.

The 97,5 percentiles (Table 13) obtained by the *BGR* are higher than those in the samples used by the *Institute for Pedology.* For the project, we determined the order of magnitude of theoretical "worst case" release on a calculative basis (see Table 15). From the values of Table 14 we calculated emission factors for each type of rock. The 97,5 percentile concentrations shown in Table 13 were transformed with the help of the emission factors to model emission values.

Table 15 – Modelling of leachate values on the basis of rock specific emission factors and concentrations in solid matter (97,5-Perzentil)

		Basalt	Diabase	Granite	Grey-wacke	Mela-phyre	Scot. Granite	Lime-stone	Devon. lime	Juras. lime
As	µg/l	80	42	543	148		185	81	45	161
Cd	µg/l	nd	Nd	nd	Nd	nd	nd	nd	Nd	nd
Cr	µg/l	13	9	31	8		13	0	15	15
Cu	µg/l	3	5	2	28		7	9	3	18
Ni	µg/l	nd	Nd	nd	Nd		nd	nd	Nd	nd
Pb	µg/l	nd	Nd	nd	Nd		nd	nd	Nd	nd
Zn	µg/l	20	24	28	10		18	7	218	169
nd = not detectable 95-Percentile- according to [MEDERER 1998], emission factors calculated on the basis of [GOETZ 1990]										

Source: Calculation Öko-Institut

The model calculation shows that elements other than arsenic might also show values above the Z-values of the *Technical Rules for Soil*. The copper value of greywacke exceeds the Z 1.2 value and the zinc value of Devonian lime and of Jurassic lime exceeds the Z 2 and the Z 1.2 value respectively. As a result, we were not able to prove on a calculative basis that natural aggregates release dangerous substances only in negligible amounts.

We recommend orienting leachate testing for aggregates from rock with higher concentrations of trace elements. Results proving that requirements of soil and groundwater protection can be complied with in all cases would be an adequate basis for a WT application.

In the project workshops, it was also proposed that naturalness or long-term tradition could be introduced as a criterion for WT classification. In fact, there are no known cases where suspect emissions from natural aggregates were documented. The criterion of naturalness, however, cannot be satisfactory from the point of view of soil and groundwater protection. It has to be proven, independently of the origin of a construction product in the sense of the obligation of precaution that no release of dangerous substances leading to an exceeding of T*ol-Values* occurs.

In the case of natural aggregates, release behaviour is only relevant, if the intended use is in unbound construction methods, where seepage water can occur. Release rates exceeding the threshold of insignificance values present a problem only, if aggregates with higher release rates are used in geologic regions with lower background levels. Such a use would be against the prohibition of deterioration. If aggregates with higher release rates are applied in their region of origin or in comparable geologic regions, it can be assumed that release rates are of the order of the regional background

levels. This also opens the option of introducing a WT cut-off criteria, which permits the use of natural aggregates used in unbound construction methods only in those geologic regions where they have been exploited or in comparable regions.

At this point, we want to stress that the above considerations do not imply that natural aggregates used in unbound construction methods are in principle unsuitable for a WT classification. They imply only that for such a classification further information on the release behaviour is required. From the available data, it cannot be deduced that natural aggregates cause far reaching environmental impacts, as primarily only the unbound construction methods are involved and secondarily only part of the rock exploited in Germany shows higher concentrations of trace elements.

It could be also of help for the classification of natural aggregates to include information gained from excavation permits. For new quarries and excavation sites, a suitability test with regard to constructional characteristics (i.e., initial type testing) has to be carried out. When the description of the aggregates shows that they are comparable to aggregates already assessed as safe for the environment, this could be used for classification purposes. Only when such experience is not available, a classification based on harmonised test methods would have to be carried out.

Natural aggregates intended for the use in water impermeable construction methods can be classified as WT.

The current state of knowledge is not sufficient to classify products intended for the use in water permeable construction methods as WT. Either orienting leaching tests on representative samples of different rock types should be carried out or already existing studies should be made available.

The information, which is gathered from the exploiting permits of new quarries or excavation sites, could be used for WT classification, as long as experience with comparable rock is available.

4.3.2 Asphalt

By far the greatest part of German roads is paved with asphalt [JENSEIT 2003]. About 5-10 % of the used asphalts, contain polymer-modified bitumen as binder. Bitumen emulsions are used for surface treatment within maintenance measures. With road abrasion, asphalt constituents (bitumen or polymer-modified bitumen, fine aggregates) and additives like polymers and adhesion agents, and in the case of bitumen emulsion also emulsifiers like N-alkylpropandiamine are released to the environment. According to estimates of the *Swiss Agency for the Environment, Forests and Landscape* (Swiss designation: BUWAL) the released amounts are negligible when compared to emissions caused by transport (combustion processes, abrasion of brakes and tyres). Furthermore, asphalts behave as an efficient barrier against the transfer of transport-caused release to soil and groundwater. The remaining dangerous substances then depend on the type of road drainage [VON ARX 1999]. A study of the *Oregon State University* concludes that constituents for the production of asphalt are toxic to algae and daphnia, but that leaching rates by precipitating water are low once the materials are bound and built-in and that further degradation and filtering occurs during passage through the soil [OREGON 2003].

Tar-containing road construction materials are not used any more. The recovery of tar-containing road demolition material is regulated in the following provisions:

- *Rules for Environmental Compatible Recovery of Reclaimed Materials with Tar/Pitch Containing Constituents and for the Recovery of Reclaimed Asphalt in Road Superstructure* [FGSV 2001b]
- *Technical Terms of Delivery for Asphalt Granulate (German designation: TL AG-StB)[FGSV 2001c]*
- *Factsheet for the Recovery of Reclaimed Asphalt Granulate (German designation: MVAG)[FGSV 2000]*

Asphalt in road construction is handled as WT, because of the water impermeability of the asphalt bound courses. According to the criteria of the *Principles for Soil and Groundwater* no reason for concern is given. The necessary restriction is that in using secondary materials as aggregates or additions, corresponding requirements of the waste law have to be complied with.

Asphalt for road construction may be classified as WT with the restriction that secondary materials used for production have to comply with waste law related regulations.

4.3.3 Concrete

In the German road network, concrete is mainly used for the construction of highways. About a quarter of the Federal highways is paved with concrete. About 3 to 5 million square meters of concrete decks are built every year. Concrete construction methods are more expensive than asphalt construction methods, but they result in lower costs for maintenance [VOLLPRACHT 2002]. In general Portland cement (CEM I) should be used for road concrete. It may be agreed with the purchaser to also use Portland slag cement (CEM II/A-S und CEM II/B-S), Portland burnt shale cement (CEM II/A-T und CEM II/B-T), Portland limestone cement (CEM II/A-L) or blast furnace cement (CEM III/A) [BMVBW 1998].

The *Institute for Building Materials Research* (IBAC), commissioned by the *DIBt,* has assessed standardised concrete constituents. The cements mentioned above, natural aggregates, melting chamber granulates, iron and steel slags, are considered harmless constituents in terms of the *Principles for Soil and Groundwater* as long as total concentrations mentioned in the positive list contained in the research report are complied with. This will also be true for recycled construction materials as concrete additive, when they comply with the limit values of the respective rules of the *German Committee of Reinforced Concrete* (German designation: DAfStb) [BRAMESHUBER 2003]. This is restricted by the critical opinion of the DIBt on the unconditional classification of construction products produced with secondary materials, because in the field of standardised products, the full characterisation of secondary materials is not ensured. The IBAC assumes, furthermore, that sufficient experimental data is available to show that aggregates used in concrete are not corroded by the alkali environment of concrete and that consequently no increased amounts of heavy metals can be released [BRAMESHUBER 2003]. Only when using greywacke the requirements of the *Alkali-Rules* [DAFSTB 2001] have to be observed to ensure a sufficient alkali resistance.

The leaching behaviour of concrete has been extensively tested. It can be assumed that even elevated trace element concentrations caused for example by the use of secondary fuels or materials are permanently bound into the concrete matrix [HOHBERG 2003]. This is true for the use phase, but not for reclaimed concrete, where the enlarged surface reduces the buffer effect and consequently increases release rates. With regard to long-term leaching behaviour of unbound reclaimed concrete, reliable studies and test methods are still lacking. A study of the *Institute for Technology Assessment and Systems Analysis* (ITAS) [ACHTERNBOSCH 2003] concludes that ideally reclaimed concrete should be used as concrete aggregate and not in unbound road construction. Due to the prohibition of dilution, secondary materials have to comply with requirements related to waste law. A research report of the *UBA* explains, which secondary aggregates and additives used in concrete should be further investigated [EHRNSPERGER 2005].

Within the discussions on the ToI-Values it was reported that typical concrete leachates may show concentrations above ToI-Values for the elements chromium, molybdenum and vanadium [LAWA 2003]. If and how far this is the case has to be further verified.

The release of dangerous substances only plays a role for water permeable construction methods and for constructions in contact with groundwater. It is necessary to wait for product related allocation values, implementing the ToI-Values to assess concrete products in water permeable construction methods or in contact with water.

Concrete used in wearing and base courses in road construction is a water impermeable construction method above the groundwater, which can be considered safe with regard to the soil and groundwater and therefore may be classified as WT, on condition that used aggregates and additions from secondary materials comply with waste related requirements.

With regard to compliance of threshold of insignificance values, we cannot assess at the current state of knowledge, whether concrete products for road construction in semi permeable construction methods or in contact with the groundwater are suited to be classified as WT. It is necessary to wait for the definition of product related allocation values and the assessment of leaching tests.

4.3.4 Secondary construction materials

Originally, it was planned to assess secondary construction materials for their suitability as WT or WFT. Iron and steel slags, melting chamber granulate and hard coal fly ash were discussed as interesting candidates. In the meantime, the UBA had commissioned the research project *Amounts, Whereabouts and Quality of Inorganic Waste*, which determines the amounts of inorganic waste in Germany, the concentrations of dangerous substances in the waste materials in question and evaluates possible effects of product related allocation values on different recovery options [DEHOUST 2005]. Results will be published shortly. As very detailed substance concentrations and leachate values will be collected, this will represent a much better data basis than the one available in the current project. It therefore did not seem justifiable to work with a state of knowledge that will soon be outdated. Furthermore, it could be advantageous to await the availability of product and material related allocation values implementing

the ToI-Values rather than to refer to the allocation values of the existing *LAGA-Rules,* which will be revised in the near future.

For the products mentioned above it seems likely that they are suitable for WFT rather than WT classification and that at least an initial type testing on the basis of harmonised European standards should be performed. If a WFT classification should not prove feasible due to variations during the industrial production process and resulting difficulty to guarantee stable material characteristics, a minimisation of testing efforts could be achieved in other ways. In the FT option, reduction of parameters tested or application of simpler test methods could also prove to be an acceptable solution for both manufacturers and authorities.

Requirements if waste law for secondary materials are implemented in the technical regulations for road construction in several „rules“ and „fact sheets“ (See Table 16). Necessary revisions concerning soil and groundwater protection are carried out in coordination with the responsible authorities.

It has been outlined in Section 3.5 that European standards for aggregates generally do not differentiate between natural aggregates and those from secondary raw materials. At the moment the national regulations for road construction add national environmental requirements for secondary materials to the European standards. When European test methods become available, levels or classes compatible with the German requirements should be added to the European standards.

Table 16– Regulations for road construction concerning secondary materials

Secondary Material	Regulation Road Construction
Recycled building materials, iron and steel slags, foundry residues, bottom ash, melting chamber granulate, hard coal fly ash	Technical terms of delivery for aggregates in road construction (TL-Gestein-StB 2004) [FGSV 2004a]
Secondary materials	Rules for the environmentally compatible use of industrial by-products and recycling building materials in road construction RuA-StB 01 [FGSV 2001a]
Reclaimed asphalt	Rules for environmental compatible recovery of reclaimed materials with tar/pitch containing constituents and for the recovery of reclaimed asphalt in road superstructure [FGSV 2001b]; Technical Terms of Delivery for asphalt granulate (TL AG-StB 2001) [FGSV 2001c] (MVAG) [FGSV 2000]
Reclaimed concrete	Factsheet for the recycling of concrete from carriageways [FGSV 1998b]
Fly ash from lignite	Indications for the use of fly ash from lignite from pulverised-coal combustion for earthworks [FGSV 2003]
Mineral mixtures from metallurgy, slags from secondary metallurgy and stainless steel slags in road construction	Factsheet for the use of mineral mixtures from metallurgy, slags from secondary metallurgy and stainless steel slags in road construction [FGSV 1998a]
Slags from metallurgy	Factsheet for the use of slags from metallurgy in road construction [FGSV 1999a]
Mineral construction products from mining activity	Factsheet for the use of mineral construction products from mining activities in road construction and earthworks [FGSV 2002b]
Colliery spoil	Technical terms of delivery for colliery spoils from hard coal mining as construction materials in road construction and earthworks [FGSV 1995] [FGSV 1994]

5 Outlook

The attraction of the WT/WFT concept lies, in the first instance, in reducing to a necessary minimum the tests required for the implementation of *Essential requirement no. 3*. In the second instance, the bottom-up approach of the concept could be a new instrument to tackle product related health and environmental protection successfully. Until now the authorities took action when environmental impacts were suspected. With the WT/WFT concept it is in the interest of the manufacturers to collect evidence for general safety. This seems much more efficient as manufacturers have comprehensive and practical knowledge about products.

In the European Union there is a trend of establishing more and more legal requirements immediately directed towards products to install a high level of protection of the environment and consumers' health. The WT/WFT concept would contribute on the one side to keeping test efforts at a level respecting the principle of commensurability. On the other side it makes sure that existing and new products effectively correspond to the same protection levels and thus avoiding that innovation is hampered by posing stricter requirements to new products.

WT or WFT classification as a side effect establishes a mechanism, which contributes to the optimisation of possible health and environment related weak spots of product groups. The classification may contribute to a general quality assurance and to a continuous development of state of the art for health and environment in product design. In this sense, all interested parties are encouraged to contribute in bringing the first WT-products on their way.

In the present report, the starting points were national requirements and developments. The next step would be to define European assessment measures and to establish a procedure for WT applications. The examples examined in the project show that many detailed questions become evident only when looking at the specific product group and that problems might differ from product group to product group. As a further step, we encourage making „test classifications" for product groups easy to classify, before finally establishing the procedure and the requirements for the application.

Abbreviations

Abbreviation	Meaning
AgBB	Committee for Health-related Evaluation of Building Products (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten)
BAM	Federal Institute for Materials Research and Testing (Bundesanstalt für Materialforschung und –prüfung)
BASt	Federal Highway Research Institute (Bundesanstalt für Straßenwesen)
BGR	Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe)
CE-Marking	The CE marking is a mandatory safety mark on many products placed on the single market in the European Economic Area. By affixing the CE marking, the manufacturer, or his representative, or the importer assures that the item meets all the essential requirements of all applicable EU directives. CE stands for both Communauté Européenne and Conformité Européenne.
CEN	European Committee for Standardization (Comité Européen de Normalisation)
CEN/TC	Technical Committee of CEN
CEPMC	Council of European Producers of Materials for Construction, Conseil Européen des Producteurs de Matériaux de Construction
CPD	Construction Products Directive 89/106/EG
CWFT	Classified Without Further Testing
DEV	German Common Procedure (Deutsches Einheitsverfahren)
DIBt	Deutsches Institut für Bautechnik (German Institute for Structural Engineering)
DIN	Deutsches Institut für Normung (German Institute for Standardisation)
EOTA	European Organisation for Technical Approvals
ETA	European Technical Approvals
FT	Further Testing
GAP	Principles of Pre-emptive Groundwater Protection With Waste Recycling and the Use of Products (Grundsätze des vorsorgenden Grundwasserschutzes für Abfallverwetung und Produkteinsatz)
IBAC	Institute for Building Materials Research (Institut für Bauforschung der RWTH Aachen)
LABO	Working group of the German Länder for Soil Protection (Bund-Länder-Arbeitsgemeinschaft Bodenschutz)
LAGA	Working group of the German Länder on Waste Issues (Länderarbeitsgemeinschaft Abfall)
LAWA	Working group of the German Länder on Water Issues (Länderarbeitsgemeinschaft Water)
LCI	Lowest Concentration of Interest

Abbreviation	Meaning
REACH	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC
SVOC	Semivolatile Organic Compounds
TC	Technical Committee
TL	Technical Term of Delivery (Technische Lieferbedingung)
TP	Technical Testing Method (Technische Prüfvorschrift)
ToI	Threshold of Insignificance (Geringfügigkeitsschwelle)
UBA	Federal Environmental Agency (Umweltbundesamt)
VOC	Volatile Organic Compounds
WT	Without Testing
WFT	Without Further Testing
ZTV	Additional Technical Terms of Contract (Zusätzliche Technische Vertragsbedingung)

Appendices

Appendix A Workshop Participants

Name	Institution
Dr.-Ing. Bertram, Heinz-Ulrich	Niedersächsisches Umweltministerium
Dr.-Ing. Bialucha, Ruth	Forschungsgemeinschaft Eisenhüttenschlacken
Böhme, Martin	Senatsverwaltung für Stadtentw.VIII Abt. 1 (LAWA)
Prof. Dr. Brameshuber, Wolfgang	ibac R OPH Aachen
Buddendick, Norbert	Deutscher Holzwirtschaftsrat (DHWR)
Däumling, Christine	Umweltbundesamt
Dinkgraeve, Dieko	Beratungs-Team Bensberg Dr.-Ing. Löffler
Drüschner, Lothar	Norddeutsche Mischwerke GmbH
Dr. Ing. Els, Heinrich	Deutscher Asphaltverband e.V.
Forg, Gerhard	maxit Deutschland GmbH
Glöckner, Martin	Deutsche Bauchemie e.V.
Dr. Grochal, Peter	StoAG
Prof. Hahn, Ulrich	Bundesverband Naturstein-Industrie e.V.
Dr.-Ing. Hildebrand, Markus	St.-Gobain Weber GmbH
Dr.-Ing. Hohberg, Inga	Deutsche Bauchemie e.V.
Dr. Horn, Wolfgang	Bundesanstalt für Materialforschung und -prüfung
Ilvonen, Outi	Umweltbundesamt
Ipawitz, Brigitte	Deutsches Institut für Bautechnik
Dr. Kanig, Martin	quick-mix Gruppe GmbH & Co.KG
Dr. Kersten, Hans-Jörg	Bundesverband der Gips- und Gipsplattenindustrie e.V.
Dr. Kirchner, Doris	Deutsches Institut for Bautechnik
Dr. Kramberger, Helge	Deutsche Amphibolin-Werke Abt. TAW / Produktsicherheit
Prof. Dr.-Ing. Krass, Klaus	Institut für Straßenwesen und Eisenbahnbau
Dr.-Ing. Motz, Heribert	Forschungsgemeinschaft Eisenhüttenschlacken
Dr. Nonte, Wilhelm	Landesamt für Umweltschutz und Gewerbeaufsicht, Mainz
Ortleb, Holger	Bundesverband Baustoffe-Steine und Erden e.V.
Dr. Pawel, Angela	Deutsches Institut for Bautechnik
Dr. Platzek, Ulrich	Deutsche Amphibolin Werke
Puch, Karl-Heinz	VGB PowerTech e.V.
Dr. Riechers, Hans-Joachim	Bundesverband Deutschen Kies- u. Sandindustrie e.V.
Dr.-Ing. Rohleder, Michael	Bundesanstalt für Straßenwesen (BASt) Ref. S 2 Erdbau, Mi-
Scherer, Christian	Fraunhofer Institut for Bauphysik
Schumacher, Markus	Bundesvereinigung Recycling-Baustoffe (BRB)
Träube, Andre	Deutscher Asphaltverband e.V.
vom Berg, Wolfgang	VGB PowerTech e.V.
Vollpracht, Anya	Institut für Bauforschung R OPH Aachen
Dr. Vogel, Ines	Umweltbundesamt
Dr. Witten, J.	Hessisches Sozialministerium

Appendix B Definitions of the Terms *Gefahrstoffe, gefährliche Stoffe, Schadstoffe* (dangerous substances, hazardous substances, pollutants) in Regulations

Soil Protection Order (BBodSchV) § 2

Pollutants: substances and preparations which, due to their harmfulness for health, their longevity or bio-availability in the soil or due to other characteristics and their concentration, are likely to harm the functions of the soil or to cause other risks.

Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances.

The following are "dangerous" within the meaning of this Directive:

(a) **explosive** substances and preparations: solid, liquid, pasty or gelatinous substances and preparations which may also react exothermically without atmospheric oxygen thereby quickly evolving gases, and which, under defined test conditions, detonate, quickly deflagrate or upon heating explode when partially confined;

(b) **oxidizing** substances and preparations: substances and preparations which give rise to a highly exothermic reaction in contact with other substances, particularly flammable substances;

(c) **extremely flammable** substances and preparations: liquid substances and preparations having an extremely low flash-point and a low boiling-point and gaseous substances and preparations which are flammable in contact with air at ambient temperature and pressure;

(d) **highly flammable** substances and preparations:

- substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or

- solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or

- liquid substances and preparations having a very low flash-point, or

- substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities;

(e) **flammable** substances and preparations: liquid substances and preparations having a low flash-point;

(f) **very toxic** substances and preparations: substances and preparations which in very low quantities cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin;

(g) **toxic** substances and preparations: substances and preparations which in low quantities cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin;

(h) **harmful** substances and preparations: substances and preparations which may cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin;

(i) **corrosive** substances and preparations: substances and preparations which may, on contact with living tissues, destroy them;

(j) **irritant** substances and preparations: non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, may cause inflammation;

(k) **sensitizing** substances and preparations: substances and preparations which, if they are inhaled or if they penetrate the skin, are capable of eliciting a reaction of hypersensitization such that on further exposure to the substance or preparation, characteristic adverse effects are produced;

(l) **carcinogenic** substances and preparations: substances or preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence;

(m) **mutagenic** substances and preparations: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce heritable genetic defects or increase their incidence;

(n) substances and preparations which are **toxic for reproduction**: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may produce, or increase the incidence of, non-heritable adverse effects in the progeny and/or an impairment of male or female reproductive functions or capacity;

(o) substances and preparations which are **dangerous for the environment**: substances and preparations which, were they to enter the environment, would present or may present an immediate or delayed danger for one or more components of the environment.

COUNCIL DIRECTIVE of 12th December 1991 on hazardous waste (91/689/EEC) (OJ L 377, 31.12.1991, p. 20)

Annex III - PROPERTIES OF WASTES WHICH RENDER THEM HAZARDOUS

H1 'Explosive': substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

H2 'Oxidizing': substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

H3-A 'Highly flammable':— liquid substances and preparations having a flash point below 21 ºC (including extremely flammable liquids), or

— substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or

— solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or — gaseous substances and preparations which are flammable in air at normal pressure, or — substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.

H3-B 'Flammable': liquid substances and preparations having a flash point equal to or greater than 21 ºC and less than or equal to 55 ºC.

H4 ‘Irritant’: non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

H5 ‘harmful’: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.

H6 ‘Toxic’: substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

H7 ‘Carcinogenic’: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

H8 ‘Corrosive’: substances and preparations which may destroy living tissue on contacts.

H9 ‘Infectious’: substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.

H10 ‘Teratogenic’: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

H11 ‘Mutagenic’: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

H12 Substances and preparations which release toxic or very toxic gases in contact with water, air or an acid.

H13 Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.

H14 ‘Ecotoxic’: substances and preparations which present or may present immediate or delayed risks for one or more sectors of the environment.

ISO GUIDE 64 [ISO 1997]

Hazardous Substance:

Substance, which can adversely affect human health ort he environment with immediate or retarded effect.

NOTE The risk of adverse effects on the environment caused by a hazardous substance is not only determined by the hazardousness of the substance, but also by the quantity and the probability of its release. The risk has therefore, to be assessed taking all these factors and the entire product life cycle into account.

Appendix C Mandates Relevant to Discussed Product Groups

C.1 Mandates Relevant to Discussed Plasters, Mortars and Gypsum boards

Intended Use	Family and Subfamily
Mandate M/106 gypsum products	
External walls, internal walls and partitions, internal wall and partition finishes	Gypsum Plasterboards Products based on calcium sulphate. They may incorporate fibres, aggregates or other additives and they may contain pigments. Gypsum products are provided either as formed products (plasterboards, ceiling tiles etc.) or as powders for mixing with water and application on site. (e.g. gypsum plasters, floor screed, etc.) Included in these terms are also ancillary components for the gypsum products. Excluded is gypsum used as an extender for paints. Subfamilies: gypsum plasterboards, gypsum sheathing boards, gypsum plasterboard composite panels, gypsum plasterboard with thin laminations, gypsum plasterboard prefabricated partition/panels, fibrous gypsum boards, preformed cornices, jointing compounds for gypsum plasterboards, gypsum based adhesives for plasterboards
	Gypsum-blocks Gypsum units with smooth faces and designed for assembly with joints using a gypsum based adhesive for construction of non load bearing partitions or self standing wall linings and for the protection of columns, lift shafts, etc. against fire, which can be finished by painting, papering etc. without application of plastering Subfamily: gypsum based adhesives for gypsum blocks)
	Gypsum based building plasters: Factory made mixture of gypsum binder and additives with or without aggregates.
Floors, galleries and ceilings, suspended ceilings, ceiling finishes	Plasterboards (see before) Subfamilies: Gypsum plasterboards, gypsum plasterboard composite panels, gypsum plasterboard with thin laminations, fibrous gypsum boards, jointing compounds for gypsum plasterboards, gypsum based adhesives
	Gypsum ceiling elements. Products manufactured from gypsum primary plaster and cast in factory. The may incorporate additives, aggregates and protected mineral fibre, tissue or glass fibre. They may be manufactured with reinforced (cohesion and rigidity provided by internal component) edges and profiles. Subfamilies: Ceiling tiles, ceiling units, gypsum adhesive
	Gypsum based building plasters Gypsum based plaster: Mixture of gypsum binder and additives with or without aggregates.
Mandate M/116 Masonry and related products	
Foundations, retaining walls, external walls, internal walls and partitions, cladding, ceiling finishes, drainage and disposal of other liquids and gaseous waste	Factory made masonry mortar A mix of water with one or more inorganic (or organic-polymer) binders, aggregates and, sometimes, additives and/or admixtures, factory made and delivered to site as dry mix, premixed lime/sand or ready mix mortars, and intended for jointing material between masonry units. The following types of masonry mortars are considered: general purpose, thin layer and lightweight. They can be designed mortars (to suit stated, mechanical characteristics) or prescribed mortar (to suit stated proportions of constituents)
	Rendering and plastering mortar

Intended Use	Family and Subfamily
	A mix of water with one or more inorganic (or organic – polymer) binders, aggregates and, sometimes, additives and/or admixtures, factory made and delivered to site as dry mix or ready mix mortars, and intended for covering externally (rendering) and internally (plastering) masonry walls or ceiling surfaces in form of one or several coats. The following types are considered: general purpose, lightweight, coloured, one coat, renovation, thermal insulating and fire resistant mortars.
Mandate M/125 Aggregates	
Floor beds, foundations and retaining walls, pile foundations, external walls, internal walls and partitions, floors, galleries and ceilings, roofs, frames, disposal of solid waste, drainage and disposal of other liquids and gaseous waste, gas supply systems, pressure and vacuum systems, electricity supply, telecommunication masts and towers, storage fixtures	Aggregates for concrete, mortar and grout Natural, manufactured, by-products of industrial processes or recycled aggregates used for the preparation of concrete and grout, mortar for use in e.g. buildings, roads and other civil engineering works
	Fillers for concrete, mortar and grout Fillers, produced from natural, manufactured by-products of industrial processes or recycled materials. Fillers are used as a component of aggregates for concrete, mortar and grout, and they are by definition inert (non-reactive). They are used to correct the aggregates in the case of a deficiency in the fine particle fraction.
Mandate M/127 Construction adhesives	
Floor beds, external walls, internal walls, partitions, floors, galleries, ceilings, roofs, frames, external and internal doors and windows, roof openings and roof lights, external wall finishes, internal wall and partition finishes, floors and stair finishes, ceiling finishes, roof finishes	Adhesives for tiles Adhesives for fixing tiles in internal and external uses, on walls, floors, ceilings and roofs (e.g. hydraulic binders, cementitious, dispersion polymers, reaction resins,…)
Mandate M 128 Products related to concrete, mortar and grout	
Floor beds, foundations and retaining walls, pile foundations, external walls, internal walls and partitions, floors, galleries and ceilings, roofs, frames, disposal of solid waste, drainage and disposal of other liquids and gaseous waste, gas supply systems, pressure and vacuum systems, electricity supply, telecommunication masts and towers, storage fixtures	Admixtures Substances added to concrete, mortar or grout during the mixing process in order to modify the properties of the mix in the fresh and/or hardened state. According to their effect, admixtures can be, for example: water reducing/plasticising admixture, air entraining, set accelerating or retarding admixtures, etc.
	Additions Type 1: pigments, ground stone, mineral fillers Type 2: silica fume, fly ash, natural and industrial pozzolana, ground granulated/vitrified/pelletised blast furnace slag
	Fibres for concrete, mortar and grout Fibres of specified material and dimension added to concrete, mortar or grout during mixing. Can be structural fibres or other fibres.

C.2 Mandates Relevant to Discussed Road Construction Products

Intended Uses	Family and Subfamily
Mandate M/124 Road Construction Products	
Floor beds (including suspended ground floors), roads and other trafficked areas, floor finishes	Bituminous mixtures for road construction with indication of type of compaction procedure, if required. Asphalt concrete including very soft asphalt and those for very thin layers, porous asphalt, mastic asphalt, stone mastic asphalt, hot rolled asphalt. These asphalts may contain reclaimed asphalt.
M/125 Aggregates	
Floor beds (including suspended ground floors), roads and other trafficked areas	**Aggregates** Granular material (natural, manufactured, by-products of industrial processes or recycled). According to their density, aggregates can be light-, normal- and heavy weight. Definition for identification of aggregates should specify source and type. *Subfamilies:* **Aggregates for concrete, mortar and grout** Natural, manufactured, by-products of industrial processes or recycled aggregates used for the preparation of concrete and grout for use in e.g. : buildings, roads and other civil engineering works **Aggregates for bituminous mixtures and surface treatments** Natural, manufactured, by-products of industrial processes or recycled aggregates used for the preparation of, or as add-ins to, bituminous mixtures and surface treatments for use in e.g. : construction of roads and surface treatment of roads and other civil engineering works **Aggregates for unbound and hydraulically bound mixtures** Natural, manufactured, by-products of industrial processes or recycled aggregates used for the preparation of unbound and hydraulically bound mixtures, excluding concrete, for use in e.g. : road construction and other civil engineering works; and arrester beds
Roads and surface treatment of roads	**Fillers** Fillers, produced from natural, manufactured by-products of industrial processes or recycled materials. Fillers are used as a component of aggregates for concrete, mortar and grout, and they are by definition inert (non-reactive). They are used to correct the aggregates in the case of a deficiency in the fine particle fraction. *Subfamilies:* **Fillers for bituminous mixtures and surface treatments** Fillers, produced from natural, manufactured, by-products of industrial processes or recycled materials, for use in e.g. construction of roads and surface treatment of roads; and other civil engineering works **Fillers for concrete, mortar and grout** Fillers, produced from natural, manufactured by-products of industrial processes or recycled materials. Fillers are used as a component of aggregates for concrete, mortar and grout, and they are by definition inert (non-reactive). They are used to correct the aggregates in the case of a deficiency in the fine particle fraction. For use in e.g.: buildings, roads and other civil engineering works;

Intended Uses	Family and Subfamily
Mandate M/128 Products related to concrete, mortar and grout	
Substances added to concrete, mortar or grout during the mixing process in order to modify the properties of the mix in the fresh and/or hardened state.	**Admixtures** According to their effect, admixtures can be, for example : Water reducing/ plasticising admixtures; High range water reducing/super plasticising admixtures; Water retaining or repelling or resisting admixtures; Air entraining and/or plasticising admixtures; Set accelerating or retarding or control admixtures; Hardening accelerating admixtures; Sagging preventing admixtures (for sprayed concrete); Corrosion inhibiting admixtures; Stabilising admixtures; Expanding admixtures; Hydration control admixtures; Bond improving admixtures; Anti-freezing admixtures; Anti-wash-out admixtures
Finely divided, nearly inert or active (pozzolanic or latent hydraulic) material that may be added to concrete, mortar and grout in order to improve certain properties or to achieve special properties. Including pigments, whose sole purpose is to colour cement and/or lime-based building materials.	**Additions** Type I (nearly inert) additions: ground stone, pigments, mineral fillers Type II (active) additions. silica fume, fly ash including fly ash obtained from co-combustion of co-combustion materials, for which the minimum percentage of coal (Kc) shall not be less than 80 % and the maximum proportion of fly ash derived from co-combustion materials (M) shall not be grater than 10 %, natural pozzolana (e.g. trass), industrial pozzolana (e.g. metakaolin), ground granulated / vitrified / pelletised blast furnace slag
Structural fibres (i.e. related to ER1), or other fibres (e.g. for abrasion minimisation).	**Fibres for concrete, mortar and grout** Fibres of specified material and dimension added to concrete, mortar or grout during mixing.

Appendix D Substance Lists

Preliminary remark on the lists for substances used in mortars and plasters

The following lists have been compiled partially with the help of the information collected within the project workshops and the individual discussions. Major part of the information collected on substances and substance groups were compiled using literature data.

The lists represent the knowledge publicly available. They do not pretend to be complete. Furthermore, they do not give evidence which substances are typically used in products today on the market, if in part exotic substances are named or if certain substances are not used any more in practice.

This kind of substantiation can be achieved only together with the manufacturers.

Objectives of the lists are to:

- Create a starting point for concise product definitions with regard to classification at WT or WFT.
- Create a starting point for the compilation of positive list of organic additives and admixtures with regard to the classification.
- Create a starting point for the compilation of a negative list.

D.1 Binders, Aggregates and Admixtures for Mortars and Plasters/Renders

Substance (Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Pressure hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Mineral Binders												
Cement[30]												1
Portland cement	Additions: max 5 % by wt. inorganic Admixtures: max 1 % by wt. inorganic									- Irritant (Xi)		1
Portland composite cement	Grinding additives: grinded blast furnace, silica, trass powder, fly ash, oil shale residues, powdered lime stone									- Irritant (Xi)		1
Blast furnace cement										- Irritant (Xi)		1
Puzzolan cement										- Irritant (Xi)		1
Composite cement										- Irritant (Xi)		1
Calcium aluminatecement (not standard in Germany)									- low hazard to water			1
Gypsum	Calcium sulphate	7778-18-9	136,14		Powder				- low hazard to water	- no labelling obligation		1 2
Lime hydrate	Calcium hydroxide	1305-62-0	74,09		Powder			- risk of serious damage to eyes	- low hazard to water	R-phrase 41		1 2
	Magnesium oxide, silica, Aluminium(II) oxide, Iron(II)oxide											1
Aggregates												
Quartz sand/ silica dust	Silicon dioxide	14808-60-7	60,08		crystals / powder			- no hazard to water				1 2
Hard aggregates	Aluminium oxide	1344-28-1	101,96	1,33					- no hazard to water			1 2
	Silicon carbide	409-21-2	40,097		crystals				- no hazard to water	- no classification		1 2

Substance (Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Pressure hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Inorganic Additions												
Limes stones lime stone, chalk, marble)	Calcium carbonate	471-34-1	100,09		powder				- no hazard to water	- no labelling obligation	- food addition	1 2
	Magnesium carbonate	546-93-0	84,31		powder						- food addition	1 2
Trass									- no hazard to water	- note dust limit value		1
Silica fume	Silicon oxide, aluminium oxide, calcium oxide, potassium oxide, sodium oxide,				powder				- no hazard to water	- note dust limit value		1
Silicic acid	Silicon oxide, Water								- no hazard to water	- note dust limit value		1
Hard coal fly ash	Silicon oxide, aluminium oxide, calcium oxide, iron oxide, magnesium oxide				powder				- no hazard to water	- note dust limit value		1
Lignite fly ash												3
Barium sulphate		7727-43-7	233,40		powder				- no hazard to water	- no labelling obligation	- white pigment	1 2
Bentonite		1302-78-9	258		powder				- no hazard to water	- note dust limit value	- food addition	1 2
Pigments	See specific table											1
Glass fibres	Calcium-Aluminium-Boron-Silicate glass							-	- no hazard to water	- note dust limit value		1
Organic Additions												
Carbon black	Carbon	7440-44-0	12,011	1,33	powder		3-5		- no hazard to water		- black pigment for food und cosmetics	1 2
Caseine	Protein mix	9000-71-9	18000-30000		powder				- no hazard to water			1 2
Organic fibres	Poly propylene	9003-07-0	n * 42,08				0,1-1		- no hazard to water	- note dust limit value		1 2
	Poly ethylene	9002-88-4	28.05		powder		0,1-1		- no hazard to water	- note dust limit value		1 2
	Polyacryl nitrile	25014-41-9			lump		0,1-1		- no hazard to water	- note dust limit value		1 2
	Cellulose	9004-34-6			powder		0,1-1		- no hazard to water	- note dust limit value	- food addition	1 2

D 2. Additives for Modified Mortars

Substance Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Typical organic raw materials/substances in cementitious modified mortars systems												
Cementitious Screeds according to EN 13813												
Dispersion powder	On the basis of mixed co-polymers:					from. 0,1 % („screeds) up to 3 % (self-levelling compounds).						
	Vinyl acetate LCI* = 36 µg/m³	108-05-4	86,09	120	liquid			- highly flammable	- hazard to water	F; R11		
	Vinyl versatate (Vinyl-trialkyl(C7-C17)acetate)											
	Ethene	74-85-1	28,05	51160	gas			- extremely flammable - vapours may cause drowsiness and dizziness		F+; R12; R67		
Cellulose ether	Basis:					0,01%- 0,2%						
	Hydroxyethylcellulose	9004-62-0			solid				- low hazard to water	- no labelling obligation		
	Methylhydroxethylcellulose											
Defoamer	On mineral carrier : - Hydrocarbons - Polyglycols					0,05% -0,3%						
Accelerator/Retarding						0,05%-25%.						
	Calcium formiate	544-17-2	130,11	-	solid			- risk of serious damage to eyes	- low hazard to water	Xi; R41		
	Lithium carbonate	554-13-2	73,89	-	solid			- harmful if swallowed - irritating to eyes	- low hazard to water	Xn; R22; R36		
	Citrate (e.g. Trisodium citrate)	68-04-2	258,07		solid				- low hazard to water			
Liquefier						0,02% -						

Substance Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
						0,5%.						
	Melamine sulfonic acids							- no irritation to skin - not toxic to reproduction - low fish toxicity	- low hazard to water - not easily biodegradable		- kitchenware - textile finishing - coatings	26
	Caseine									- not classified		
	Naphthalene sulfonate	68425-94-5							- low hazard to water - do not fulfil criteria for easy biodegradability	- Irritant (Xi) - R-phrase: 36/38	- flotation processes - textile finishing	4 6 26 31
	Poly carboxylate							- acrylates may irritate skin and mucous membranes - maleinate, polyglycol ether are irritant	- low hazard to water some water endangering - potentially biodegradable	- Irritant (Xi)	- dispersion aid for paints - super absorber for hygiene goods	26
Cementitious Adhesives for Tiles according to EN 12004												
Dispersion powder	On basis of mixed copolymers:		6			up to 4,5%.						
	Vinyl acetate NIK = 36 µg/m³	108-05-4	86,09	120	liquid			- highly flammable	- hazard to water	F; R11		
	Ethene	74-85-1	28,05	51160	gas			- extremely flammable - vapours may cause drowsiness and dizziness		F+; R12; R67		
	Vinyl versatate (Vinyl-trialkyl(C7-C17)acetate)											
	Methacrylate NIK = 180 µg/m³	96-33-3	86,09	91	liquid			- highly flammable - harmful by inhalation, in contact with	- hazard to water	- F; R11 Xn; R20/21/22 Xi; R36/37/38 R43		

Substance Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								skin and if swallowed - irritating to eyes, respiratory system and skin - may cause sensitisation by skin contact				
	Styrene acrylate NIK = 110 µg/m³											
Cellulose ether			7			0,1% – 0,5%.						
	Methylcellulose, partially modified											
	Methylhydroxypropylcellulose											
Starch ether			8			0,05% - 0,2%						
Cellulose fibres	On the basis of technical cellulose		9			0,3% - 0,7%						
Accelerator/retarding agent			10			0,1% - 3,0%						
	Calcium formiate	544-17-2	130,11		solid			- risk of serious damage to eyes	- low hazard to water	- Xi; R41		
	Lithium carbonate	554-13-2	73,89		solid			- harmful if swallowed - irritating to eyes	- low hazard to water	- Xn; R22; R36		
	Citrate (Example Trisodium citrate)	68-04-2	258,07		solid				- low hazard to water	- no classification		
PCC according to EN 1504												
Dispersion powder	On the basis of mixed copolymers:		11			2%-4%						
	Vinyl acetate NIK = 36 µg/m³	108-05-4	86,09	120	liquid			- highly flammable	- hazard to water	- F; R11		
	Ethene	74-85-1	28,05	51160	gas			- extremely flammable - vapours may		- F+; R12; R67		

Substance Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								cause drowsiness and dizziness				
	Vinyl versatate							-				
	Styrene NIK = 860 µg/m³	100-42-5	104,15	7	liquid			- flammable - harmful by inhalation - irritating to eyes and skin	- hazard to water	- Xn; Xi ; R10; R20; R36/38		
	Acrylate NIK = 110 µg/m³											
Defoamer	On inorganic carrier: - Hydrocarbons - Polyglycols		12			0,05% - 0,3%						
Accelerator			13			0,02% - 0,3%						
	Calcium formiate	544-17-2	130,11	-	solid			- risk of serious damage to eyes	- low hazard to water	- Xi; R41		

D. 3 Aggregates, Additions und Admixtures for Organic Plasters/Renders

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Organic Plasters/Renders												
Synthetic dispersions (Acrylate co-polymer)							20					7
Ground lime stone (0,1 to 1 mm)							60					7
Accelerator	Calcium formiate	See additives					0,7					
Silicates	Magnesium silicate hydrate (talcum)	14807-96-6	379,29		powder		7	- harmful by inhalation	- no hazard to water	- R-phrase: 20	- food industry	4 7 32
	Kieselguhr	61790-53-2	60,09		powder		0,5-5,0		- no hazard to water	- no legal classification		4 20 21 32
Cellulose	Hydroxyethyl cellulose (30.000 mPa 2%ig)	See stabilizers					0,5					7
	Hydroxypropylguar (Addilose 75 or Esacol HS 20)	39421-75-5										14
Retarding agent	Citric acid	77-92-9	192,12	<0,1 (20 °C)			0,3	- risk of serious damage to eyes - Irritating to respiratory system and skin	- biodegradable	- R-phrase: 41-37/38	- detergent - food industry	15
	Calcium salts of N-polyoxymethylen- nitrogenic acid (Retardan P)											7

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Surfactant	Sodiumlaurylsulfate	151-21-3	288,38		crystals, flakes or powder		0,2	- harmful by inhalation and if swallowed - may cause sensibilisation by inhalation - irritating to eyes, respiratory system and skin - risk of explosion when heating under confinement	- hazard to water	- R-phrase: 20/22-42-36/37/38-44		4
	Calcium carbonate	See anti-freezing agents										
Preservative	1,2-Benzisothiazol-3(2H)-on	2634-33-5	151,19				< 0,008	- harmful if swallowed - irritating to skin - risk of serious damage to eyes - may cause sensitisation by skin contact - very toxic to water organisms		- R-phrase: 22-38-41-43-50		4 21
	2-Methyl-4-isothiazolin-3-on	2682-20-4	115,15				< 0,008	- causes burns - harmful by inhalation, in contact with skin and if swallowed - may cause sensitisation by skin contact		- R-phrase: 34-20/21/22-43		4 21
Defoamer							0,1 - 0,3					23 24
Silicic acid												24
Not ionic emulsifier	Polyamine-ethylenoxide-condensate					100						23 24
Hydrocarbons												23 24

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Film forming agents	2-[2-(Butoxi)ethoxi]-ethanol (Di-ethylenethanediolmonobutylether)	112-34-5	162,23	0,055 (20 °C) 0,3 (50 °C)	hygroscopic liquid			- irritant to eyes	- low hazard to water - biodegradable	- R-phrase: 36		6
	1.2-Propandiol	57-55-6	76,10	0,11 (20 °C) 0,3 (25 °C)	hygroscopic liquid				- no hazard to water - easily biode-gradable		- food industry	4 6
	Solventnaphtha (Benzen)	71-43-2	78,11	101 (20 °C)	liquid			- may cause cancer - may cause herita-ble genetic damage - highly flammable - irritatory to eyes and skin - toxic: danger of se-rious danger to health by pro-longued exposure through inhalation, contact with skin and if swallowed - harmful: may cause lung damage if swallowed	- severe hazard to water	- R-phrase: 45-46-11-36/38-48/23/24/25-65		6
Super Plasti-ciser	Polypropylenglycolalkylphenylether (Plastilit 3060)	25322-69-4	200 - 4000	< 0,013 (20 °C)	viscose liq-uid		1,6	- harmful if swal-lowed	- no hazard to water - non biodegrad-able	- R-phrase: 22		4
EP-Hardener												9
Modified cycloaliphatic polyamine adduct / modified hetero-cyclic poly amines	Hexamethylentetramine (Metheneamine)	100-97-0	140,19	0,0035 (20 °C)	crystals / powder		0,4		- low hazard to water			4 16
	Methylmethacrylate	80-62-6	100,12	37 (20°C) 47 (20°C)	liquid		50-100	- highly flammable - irritating to respira-tory system and skin - may cause sensiti-sation by skin con-tact	- low hazard to water	- R-phrase: 11-37/38-43		4 25
	N,N-dimethyl-p-toluidin	99-97-8	135,21	0.1	liquid		<	- toxic by inhalation,	- low hazard to	- R-phrase:		25

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
				(20°C)			2,5%	in contact with skin and if swallowed - danger of cumula-tive effects - harmful to aquatic water organism - may have long-term adverse effects in the aquatic envi-ronment	water	23/24/25-33-52-53		32
	Phosphoric acid ester of hydroxy-toluene	78-32-0	368,37		oily liquid		< 2,5%	- harmful in contact with skin and if swallowed - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic envi-ronment	- low hazard to water	- R-phrase: 21/22-51/53		4 25
	Triethylentetramine	112-24-3	146,24	<0,1 (20 °C)	liquid			- harmful in contact with skin - causes burns - may cause sensiti-sation in contact with skin - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic envi-ronment	- hazard to water	- R-phrase: 21-34-43-52/53		4 16
	Isophorondiamine (3-Aminomethyl-3,5,5-trimethyl-cyclohexylamine)	2855-13-2	180,25	0,02 (20 °C)	liquid		10-25%	- harmful in contact with skin und if swallowed - causes burns - may cause sensiti-sation in contact with skin - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic envi-ronment	- low hazard to water	- R-phrase: 21/22-34-43-52/53		4 25 32
	Phenylglycidylether	122-60-	150,19	0,013	liquid			- may cause cancer	- hazard to water	- R-phrase:		4

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
		1		(25 °C)				- harmful by inhalation - irritating for the respiratory system and skin - may cause sensitisation by skin contact - possible risks of irreversible effects - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic environment		45-20-37/38-43-68-52/53		16 32
	4,4'-Diaminodiphenylmethane	101-77-9	198,27	0,06 (20 °C)	crystals or powder			- may cause cancer - toxic: danger of serious irreversible effects through inhalation, in contact with skin and if swallowed - may cause sensitisation by skin contact - harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed - possible risks of irreversible effects - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment	- severe hazard to water	-R-phrase: 45-39/23/24/25-43-48/20/21/22-68-51/53		4 16 32
	n-Butylacrylate	141-32-2	128,17	4,3-5,3 (20 °C)	liquid		10-25	- flammable - irritatory to eyes, respiratory system and skin	- low hazard to water	- R-phrase: 10-36/37/38-43		4 25

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								- may cause sensiti-sation by skin con-tact				
	Dibenzoylperoxide	94-36-0	242,23		powder		50-100	- risk of explosion by shock, friction, fire or other sources of ignition - irritant to eyes - may cause sensiti-sation by skin con-tact	- hazard to water	- R-phrase: 2-36-43		4 25
	Dicyclohexylphthalate	84-61-7	330,43	0,6 (140 °C)	powder			- irritatory to eyes, respiratory system and skin	- low hazard to water	- R-phrase: 36/37/38		4 25 32
	Trimethylhexamethylendiamine	25620-58-0	158	0,02 (20 °C)	liquid		< 2,5	- harmful if swal-lowed - causes burns - may cause sensiti-sation by skin con-tact - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic envi-ronment	- hazard to water	- R-phrase: 22-34-43-52/53		32
Mannich-base	2,4,6-Tris-(dimethylaminomethyl)-phenol	90-72-2	265,40	0,1 (20 °C)	liquid			- harmful if swal-lowed - irritating to eyes and skin	- hazard to water	- R-phrase: 22-36/38		4 19
Epoxy resin	Low-molecular bisphenol-A-resin, e.g. bisphenol A	25068-38-6					50-100	- irritating to eyes and skin - may cause sensiti-sation by skin con-tact - toxic for aquatic or-ganisms, may cause long-term adverse effect in the aquatic envi-ronment	- low hazard to water	- R-phrase: 36/38-43-51/53		4 25

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
	Bisphenol F	2467-02-9	200,24		solid		2,5-10	- irritatory to eyes, respiratory system and skin		- R-phrase: 36/37/38		4 18 32
	3,6,9-Triazaundecan-1,11-diamine	112-57-2	189,31	<0,013 (20 °C)	hygroscopic liquid		< 1,5	- harmful in contact with skin und if swallowed - causes burns - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment		- R-phrase: 21/22-34-43-51/53		4 25
Reactive thinners	Cresylglycidylether	26447-14-3	163,20	2 (20 °C)	liquid			- irritating to skin - may cause sensitisation by skin contact - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment - possible risks of irreversible effects	- hazard to water	- R-phrase: 38-43-51/53-68		16 17 32
	Butylglycidylether	2426-08-6	130,19	3,5 (20 °C) 12 (50 °C)	liquid			- flammable - harmful by inhalation and if swallowed - irritating for the respiratory system - limited evidence of a carcinogenic effect - may cause sensitisation by skin contact - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic environment - possible risk of irre-	- hazard to water	- R-phrase: 10-20/22-37-40-43-52/53-68		4 32

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								versible effects				
	C12-C14-Alkylglycidylether	68609-97-2					2,5-10	- irritating to skin - may cause sensiti-sation by skin con-tact		- R-phrase: 38-43		25 32
	1,6-Hexandiglycidylether	16096-31-4					2,5-10	- irritatory to eyes and skin - may cause sensiti-sation by skin con-tact - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic envi-ronment		- R-phrase: 36/38-43-52/53		25
	Trimethylolpropantriglycidylether	30499-70-8					10-25%	- irritatory to eyes and skin - may cause sensiti-sation by skin con-tact - harmful to aquatic organisms, may cause long-term adverse effect in the aquatic envi-ronment		- R-phrase: 36/38-43-52/53		25
Others	Benzyl alcohol	100-51-6	108,14	0,05 (20°C) 0,19 (25°C) 17,7 (100°C)	liquid			- harmful by inhala-tion and if swal-lowed	- low hazard to water	- R-phrase: 20/22		4 25
	Xylen(Isomeric mix)	1330-20-7	106,17	7-9 (20 °C)	liquid		< 2,5	- flammable - harmful by inhala-tion und in contact with skin - irritating to skin	- hazard to water	- R-phrase: 10-20/21-38		4 25
	Alkyl benzene	64742-95-6					< 1,5	- may cause cancer - harmful: may cause lung damage if swallowed		- R-phrase: 45-65		4 25
Thixotroping agents	Attapulgit	12174-11-7	411.35		fine powder				- no hazard to water			12 13

Substance(group)	Chemical Constituents	CAS-Number	Molar weightg/mol	Vapour Press. hPa	Quality	% Addi-tive	% Pro-duct	Toxicology	Hazard to Water	Labelling	Further Uses	Source
												32

D.4 Pigments Used in Mortars for Plasters/Renders

Substance (Group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Pigments												
green	Chromium(III)−oxide	1308-38-9	151,99	0,0 (20 °C)	powder			- harmful through inhalation, in contact with skin and if swallowed - irritatory to eyes, respiratory system and skin - may cause sensitisation by skin contact	- no hazard to water	- R-phrase: 20/21/22-36/37/38-43		4 22
	Chromium-6-compounds	18540-29-9						- may cause sensitisation by skin contact - may cause cancer by inhalation - very toxic for aquatic organisms, may cause long-term adverse effects in the aquatic environment	- severe hazard to water	- R-phrase: 43-49-50/53		23 32
	Heliogen green	14302-13-7	1393,98									4 23
	Cobalt green											23
red	Iron(III)-oxide	1309-37-1	159,69		crystals			- irritatory to eyes, respiratory system and skin	- no hazard to water	- R-phrase: 36/37/38	- food industry	4 22 32
yellow	Nickel titan yellow (Pigment yellow 53)	8007-18-9			powder				- no hazard to water			4 23
brown	Manganese brown											23
blue	Heliogenblue	147-14-8	576,08		powder				- no hazard to water			4 23 32
	Han-Blue ($BaCuSi_4O_{10}$)											23
	Egyptian blue ($CaCuSi_4O_{10}$)											23
	Cobalt blue (Cobalt aluminate)	68186-86-7			powder							4 23
black	Manganese black	1313-13-9	86,94	0 (20 °C)	powder			- harmful by inhalation and if swallowed	- low hazard to water	- R-phrase: 20/22		4 23

Substance (Group)	Chemical Con-stituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Addi-tive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
												32
	Manganese grey											23
White	Titanium dioxide	13463-67-7	79,9		crystals/ powder				- no hazard to water	- note dust limit value		

D.5 Admixtures for Concrete, Mortars and Plasters

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Admixtures for Concrete and Mortar												
Water reducing agent (main component lignin sulfonic acids)	Mg-ligninsulfonate, naphthalene sulfonic acid polycondensate, sodiumgluconate				watery solution, free of organic solvents	10-40	0,2-0,5		- low hazard to water - not easily biodegradable	- no labelling obligation		26
Super Plasticizer (mainly melamin-sulfonic acid, naphthalene sulfonic acid, poly carboxylates)					watery solution, free of organic solvents	10-40	0,8-2		- low hazard to water - not easily biodegradable	- no labelling obligation		26
Lignin sulfonic acid compound	Highly polymeric natural substance, e.g. ligninsulfonic acid compounds	8061-51-6			powder				- low hazard to water - potentially biodegradable		- pelletation aid for fodder	1 6
	Triethanolamine	102-71-6	149,19	0,01 (20 °C); 0,0000000477 (25 °C)	liquid (oil)			- irritating to eyes, respiratory system and skin	- biodegradable - low hazard to water	- R-phrase: 36/37/38		4
Melamine sulfonates	Melamine-formaldehydecondensates								- low hazard to water - not easily biodegradable		- kitchen ware - textile finishing - coatings	26
	Trimethylolmelamine	1017-56-7	216,19									4
Naphthalene sulfonate	Naphtalene- Formaldehyde-condensates, e.g. Naphtalenesulfonic acid formaldehyde-condensate	68425-94-5						- irritatory to eyes and skin	- low hazard to water - not easily biodegradable	- R-phrase: 36/38	- flotation processes - textile finishing	4 6 26 31
	Naphthalene-2-sulfonic acid	120-18-3	208,24		solid			- causes burns		- R-phrase: 34		4 32
Poly carboxylates	Sodium salt, organic Carbonic acids - Acrylate								- low hazard to water partially hazard to water		- dispersion aids for paints - superab-	26

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
	- Maleinate - Derivates of polyglycolethers - Polymerisation products with styrene								- potentially biodegradable		sorber in hygiene articles	
Defoamer							0,5 %					26
	Tributyl phosphate	126-73-8	266,32	0,08 (20 °C) 0,008 (20°C)	liquid			- harmful if swallowed - irritating to skin - possible risks of irreversible effects	-hazard to water	- R-phrase: 22-38-40		4 26
Silicon organic-compounds	Polydimethylsiloxane (rubber)	63394-02-5							low hazard to water - persistent		-food additive	4 26
Nonylphenolethoxilate	See *tensides*											6
Preservation												
Quarternary ammonium salts												
Formaldehyde / (Formaldehyde releasing compounds)	Formaldehyde	50-00-0	30	69	watery solutions		0,1 % by wt.	- toxic by inhalation, contact with skin and if swallowed - causes burns; - limited evidence of a carcinogenic effect; - may cause sensitisation by skin contact.	- hazard to water	- R 23;24;25;R 34; R 40; R 43; Carc.Cat.3;	- preservation of cosmetics	26
Phenolic compounds	Benzoic acid	65-85-0	122,12	1,3 (96 °C)	crystalline powder			- harmful by inhalation, in contact with skin and if swallowed - May cause sensitisation by inhalation or skin contact - irritating to eyes, respiratory system and skin	- low hazard to water biodegradable	- R-phrase: 20/21/22-42/43-36/37/38	- food additive	4 26

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
	p-Chloro-m-kresol	59-50-7	142,59	0,08 (20 °C)	crystalline powder		- 0,2-0,5	- harmful in contact with skin und if swallowed - risk of serious damage to eyes - may cause sensitisation by skin contact - very toxic for aquatic organisms	- hazard to water	-R-phrase: 21/22-41-43-50	- preservation of cosmetics - disinfectant	4
	o-Phenylphenol	90-43-7	170,21	9,33 (140 °C) 0,002266 (20 °C)	crystalline chips		0,2-0,5	- irritatory to eyes, respiratory system and skin - very toxic for aquatic organisms	- hazard to water	- R-phrase: 36/37/38-50		4
Isothiazolinon preparations	Chloromethylisothiazolon + Methylisothiazolilon (Kathon)	55965-84-9					0,020,2	- toxic by inhalation, in contact with skin and if swallowed - causes burns - may cause sensitisation by skin contact - very toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment	- severe hazard to water	- R-phrase: 23/24/25-34-43-50/53	- preservation of cosmetics	26
Retarding agent					powder or . watery solution, free of organic solvents	10-30	0,2-2					26
	Ligninsulfonic acid (see plasticisers)											3 26
	Hydroxycarbonic acid (see recycling aids)											3
Saccharoses	Beet and cane sugar	57-50-1	342,30		crystals				- no hazard to water			4

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Gluconates	- Sodiumglucoheptonate	31138-65-5							- low hazard to water		- food additive	26
Phosphates	Tetrapotassiumpyrophosphate	7320-34-5	330.35					- irritatory to eyes, respiratory system and skin		- R-phrase: 36/37/38		3 4 26
	Sodiumtripolyphosphate	7758-29-4	367,86		powder			- irritatory to eyes, respiratory system and skin	- low hazard to water	- R-phrase: 36/37/38	- food industry	4 6 26
	Sodiumhexametaphosphat	10124-56-8	611,76					-			-manufacture of paints - refrigerants	4 6 26
	EDTA (Ethylendiamintetra acetic acid)	60-00-4	292,25	< 0,013 (20 °C)	crystals			- irritatory to eyes, respiratory system and skin	- hazard to water	- R-phrase: 36/37/38		4 32
	Zinc oxide	1314-13-2	81,37		powder			- very toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment	- hazard to water	- R-phrase: 50/53	- pharmaceutical products - manufacture of paints	4
	Lead oxide	1314-41-6 / 1317-36-8 / 1335-25-7	223,19-685,57		powder			- harmful by inhalation and if swallowed - danger of cumulative effects - may cause harm to the unborn child		-R-phrase: 20/22-33-61	- manufacture of paints	4
Accelerator						10-100	3-5	-				
	Morpholine	110-91-8	87,121	10 (20°C)	hygroscopic oil			- flammable - harmful by inhalation, in contact with skin and if swallowed - causes burns	- hazard to water	- R-phrase: 10-20/21/22-34		4
	Calcium chloride	10043-52-4	110,99		hygroscopic crystals			- irritant to eyes	- no hazard to water	- R-phrase: 36	- paints	3 4
	2,4,6-Tris-(N,N-dimethylaminomethyl)-phenol	90-72-2	265,40	0,1 (20 °C)	liquid			- harmful if swallowed - irritating to eyes and skin	- hazard to water	-R-phrase: 22-36/38		4 9

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
	Sodiumthiocyanate	540-72-7	81,07		flowing crystals			- harmful by inhalation, in contact with skin and if swallowed - contact with acids liberates very toxic gases	- low hazard to water biodegradable	- R-phrase: 20/21/22-32		4 25
	Alkylamine oxide	85408-48-6						- irritating to skin - risk of serious damage to eyes - very toxic for aquatic organisms		- R- phrase: 38-41-50		25
	Potash lye (Potassiumhydroxid solution)	1310-58-3	56,11	0 (20 °C) 2,6-2,9 (15,6 °C)?	liquid			- harmful if swallowed - causes severe burns	- low hazard to water	- R-phrase: 22-35		4 25
Silicates	Sodium or potassium salts								- low hazard to water		- - drinking water purification - -soil stabilisation - - detergent	26
Aluminates	Sodium aluminate (Potassiumaluminate)	1302-42-7	81,97		alkalic liquid			- causes burns	- low hazard to water	- R-phrase: 34		4 26
Carbonates	Sodium carbonate (Soda)	497-19-8	105,99		hygroscopic crystals			- irritant to eyes	- low hazard to water	- R-phrase: 36		4 26
	Potassium carbonate (Potash)	584-08-7	138,21		powder or granulate			- harmful if swallowed - irritant to eyes and skin	- low hazard to water	- R-phrase: 22-36/38	- food industry	4 26
Formiates	Calcium formiate	744-17-2							- low hazard to water	- no labelling obligation	- food preservation -ensilage of green fodder	4 26
Amorphic aluminium hydroxides	Aluminium hydroxide	21645-51-2	78,00		amorphic powder; monocline crystals				- no hazard to water	- note dust limit value	- manufacture of paints	4 26
	Aluminium sulphate	10043-01-3	342,14		crystals or powder				- low hazard to water	- irritant (Xi) (Self-classification)	- photo industry	4 26 33

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Air entraining agents						2-20	0,05-1					26
Soap from natural resins	Saponified tall , balsam (colophony) or wood resins				powder or watery solution				- unsaponified resins are low hazard to water - saponified resins in watery solution are hazard to water - biodegradable		- food industry (chewing gum) - adhesives - plastics	26
Synthetic Tensides	Alkylpolyglycolether, akylsulfates und sulfonic acids								- hazard to water - easily biodegradable		- personal hygiene - detergents	6 26
	Alkylphenolethoxylate, e.g. nonylphenolethoxylate	68412-54-4						- harmful if swallowed - irritating to eyes and skin	- hazard to water - persistent	- R-phrase: 22-36/38	- textile industry - production of paints - industrial cleaning agents - ingredient for bitumen and emulsions	4 6
Gas forming agents	- Cocosalkyldimethylaminoxide - Polypeptid-alkylenpolyol on protein basis											7
	Sodium-Olefin-sulfonate (Sodiumalcanesulfonate)	85711-69-9						- irritating to skin - risk of serious damage to eyes	- hazard to water	- R-phrase: 38-41		25 32 34
	- Aluminium powder - Aluminium paste	See										7
	Methoxypropanol Diethylenglycol											7
	Hydrogen peroxide	7722-84-1	34,01	30,05 (30 °C)	liquid			- heating may cause an explosion - contact with combustible material may cause	- low hazard to water	- R-phrase: 5-8-20/22-35	- bleaching agent oxidising - antimicrobial	4 30

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								fire - harmful by inhalation and if swallowed - causes severe burns				
	Butylglycol	111-76-2	118,18	1,3 (20 °C)	oily liquid			- harmful by inhalation, if swallowed and in contact with skin - irritatory to eyes and skin	- low hazard to water - biodegradable	- R-phrase: 20/21/22-36/38	- detergent	3 4
								-				
Waterproofing Agents						20-50	- 1-5	-				26
Salts of higher fatty acids	- Oleic acid - Fatty alcohol ethoxylate - See also additives								- no hazard to water - biodegradable	no labelling obligation		26
	- Calcium stearate	1592-23-0	283,48		granular, oily powder				- no hazard to water - biodegradable	no labelling obligation	- cosmetics - food industry	4 26
	Sulfosuccinic acid dioctylester, sodium salts	577-11-7	444,55		flakes	< 2,5		- harmful if swallowed - irritant to eyes	- low hazard to water	- R-phrase: 22-36	pharmaceutical auxiliary agent	4 25
Ligninsulfonate (see liquefiers)												
Grouting agents						0,1-1	0,2-1					26
	Metallic aluminium	7429-90-5	26,98		powder			- Contact with water liberates extremely flammable gases - Spontaneously flammable in air	- no hazard to water	- R-phrase: 15-17	- food colours	4 26
Stabilizers						0,1-1	0,15 to 0,3					26
	Silicon dioxide	7631-86-9	60,08	13,33 (1732 °C)	watery solution	20		- harmful by inhalation	- no hazard to water	- R-phrase: 20		4 32
Polysaccharides	- Starch ether - Silicafume formulations								- low hazard to water	-no labelling obligation		26

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
									- easily biodegradable,			
	Guar derivates e.g. guar gum	9000-30-0	220		powder				- no hazard to water		- food addition	4
Cellulose ethers	Methylhydroxypropyl cellulose	9004-64-2			powder						- food addition	4 7
	Methyl cellulose (HEC)	9004-67-5			powder				- persistent			4 7
	Sodium-Carboxymethyl cellulose (Na-CMC)	9004-32-4			crumbly mass				- low hazard to water			4 7
	Hydroxyethyl cellulose	9004-62-0							- no hazard to water			4 7
	Methylhydroxyethylcellulose, Hydroxypropylcellulose, Ethyl-HEC (EHEC), Methyl-Ethyl-HEC (MEHEC), Butylglycidylether-HEC, Laurylglycidylether-HEC, carboxymethylized MHEC bzw. MHPC, Hydromellosephtalate											7
Xanthan Gum		11138-66-2	> 10 exp 6		powder						- food industry - production of paints	4 7
Borax, boric acid		10043-35-3	61,83					- harmful in contact with skin und if swallowed - irritatory to eyes, respiratory system and skin	- low hazard to water	- R-phrase: 21/22-36/37/38		4 7 32
Recycling agents						10-20						26
Phosphonic acid	2-Phosphanobutan-1,2,4 tricarbonacid	37971-36-1	270.13		watery solution				- low hazard to water	- no labelling obligation	- water treatment - liquid detergent in food industry	4 26
Fruit acids (Hydroxycarbon acids)	- Citric acid - Tartaric acid (see Admixtures for Mortars) - Gluconic acid - Lactic acid - Malic acid				watery solution				- no hazard to water - easily biodegradable		- food industry	26

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Chromate reducers							0,2-0,5					26
	iron(II)-sulfate	7720-78-7	151,91		powder or granulate			- harmful if swallowed	- low hazard to water	- R-phrase: 22	- water chemistry - special fertilisers - desulphurisation of biogas	26 32
Hydrophobing agents												28
Silicon organic compounds (Silicon resins)	- Alkoxysilane (Triethoxyoctylsilane) - Alkoxysiloxanes(oligomeric und polymeric siloxanes) - Silicone resins (alkylpolysiloxane) - Alkalisiliconates (potassiumsiliconate)				- solved in organic solvents - with emulsifiers as watery solution				- hazard to water			28
	Example: Triethoxy(2,4,4-trimethylpentyl)silane	35435-21-3		6,0 (25 °C)					- not easy biodegradable			4
Emulsifiers (tensides) see also air entraining agents	- Cationic emulsifiers - Anionic emulsifiers - Non-ionic emulsifiers - Silicon organic emulsifiers								- hazard to water - easily biodegradable			28
Metal organic condensation catalyser	Calcium stearate (see waterproofing agents)											
	Zinc stearate	557-05-1	632,33		powder			- harmful by inhalation	- low hazard to water	- R-phrase: 20	- cosmetics industry	4
Solvents	- Aromatic free hydrocarbons - Synthetic isoparaffines							-	- low hazard to water			28 7
Alcanes	Hexane	110-54-3	86,17	160 (20 °C)	liquid			- highly flammable - irritating to skin - harmful: danger of severe damage to health by prolongued exposure through inhalation - may impair fertility - harmful: may	- low hazard to water	- R-phrase: 11-38-48/20-62-65-67-51/53		4 27

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								cause lunge damage if swallowed - vapours may cause drowsiness and dizziness - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment				
Ketones	Acetone	67-64-1	58,08	240 (20 °C)	liquid			- highly flammable - irritant to eyes - repeated contct may cause skin dryness or cracking - vapours may cause drowsiness and dizziness	- low hazard to water	- R-phrase: 11-36-66-67		4 27
Alcohols	Isopropanol	67-63-0	60,10	42,5 (20 °C)	liquid			- highly flammable - irritant to eyes - vapours may cause drowsiness and dizziness	- low hazard to water	- R-phrase: 11-36-67	-Cosmetics industry	4 7 27
	1-Butanol	71-36-3	74,12	5,8-7,4 (20 °C)	liquid			- flammable - harmful if swallowed - Irritating to respiratory system and skin - risk of serious damage to eyes - vapours may cause drowsiness and dizziness	- low hazard to water - easily biodegradable	- R-phrase: 10-22-37/38-41-67		4 27
Aromatic mineral spirits	Toluene	108-88-3	92,14	29 (20 °C)	liquid			- flammable - irritating to skin	- hazard to water	- R-phrase: 11-38-48/20-		4 7

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								- harmful: danger of damage to health by prolongued exposure through inhalation - may cause harm to the unborn child - harmful: may cause lunge damage if swallowed - vapours may cause drowsiness and dizziness	- biodegradable	63-65-67		27
	Benzene	71-43-2	78,11	101 (20 °C)	liquid			- may cause cancer - may cause heritable genetic damage - highly flammable - irritatory to eyes and skin - toxic: danger of serious danger to health by prolongued exposure by inhalation, contact with skin and if swallows - harmful: may cause lung damage if swallowed	- severe hazard to water - easily biodegradable	- R-phrase: 45-46-11-36/38-48/23/24/25-65		4 27
	Trimethylbenzene		120,19	2-6 (20°C)	liquid			- flammable - irritating for the respiratory system - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic envi-	- hazard to water	- R-phrase: 10-37-51/53		4

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								ronment				
	Ethylbenzene	100-41-4	106,17	9-13,33 (20 °C)	liquid			- highly flammable - harmful by inhalation	- low hazard to water	- R-phrase: 11-20		4 27 32
	o,m,p-Xylen	1330-20-7	106,17	7-9 (20 °C)	liquid			- flammable - harmful by inhalation und in contact with skin - irritating to skin	- hazard to water	- R-phrase: 10-20/21-38		4 27 32
	- Ethenylbenzen (Styrene)	100-42-5	104,15	6 (20 °C)	liquid			- flammable - harmful by inhalation - irritatory to eyes and skin	- hazard to water	- R-phrase: 10-20-36/38		4 27
Additives												
Fatty acids	- Stearic acid - Oleic acid								- saturated linear, even-numbered C-chains with at least 14 C-atoms: no hazard to water - other fatty acids: low hazard to water - easily biodegradable		- tensides - cosmetics - food industry	7 29
Fatty acid esters									- linear, even-numbered C-chains with at least 12 C-atoms: no hazard to water - other fatty acid esters: low hazard to water - easily biodegradable		- food industry	29
Fatty alcohols									- saturated, linear, even-numbered C-chains with at least 12 C-		- ten sides - cosmetics	29

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
									atoms und unsaturated, even-numbered, linear C-chains with 16 und 18 C-Atoms: no hazard to water - other fatty alcohols: low hazard to water - easily biodegradable			
Others	Sulfohydroxypoly(oxy-1,2-ethandiol)-C10-C16-alkylether, Sodiumsalt	68585-34-2										25
Thixotroping agents												8
	Hardened castor oil											
Layered silicates	Talcum	14807-96-6	379,29		powder			- harmful by inhalation	- no hazard to water	- R-phrase: 20	- food addition	4 7 32
	Kaolinite	1318-74-7			powder				- no hazard to water			4 7
	Bentonite	1302-78-9			powder			- irritatory to eyes, respiratory system and skin		- R-phrase: 36/37/38		4 7
	Montmorillonite	1318-93-0										4 7
	Hektorite	12173-47-6										4 7
Fibrous silicates	Sepiolithe	1343-90-4							- no hazard to water	no legal classification		7 32
	Wollastonite	10101-39-0	116,16							no legal classification		4 7
	Attapulgite	12174-11-7							- no hazard to water	no legal classification		4 7
	Potassium silicate	1312-76-1	248.44	0,00025-0,01 (999 °C)			< 0,35	- irritatory to eyes and skin	- low hazard to water	- R-phrase: 36/38		4 21
Corrosion inhibitors												
	- Calcium sulfonate - Succinic acid semi-ester - Fatty amines								- low hazard to water - hazard to wa-			29

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
	- Melamine-naphthalene sulfonate								ter - potentially biodegradable			
Silicates												8
Poly phosphate												8
Tannin-derivates												8
Zinc salts organic nitrogenic acids												8
	Calcium- und Sodium nitrite	See anti-freezing-agents							- hazard to water			
	Sodium-chromate	7775-11-3	161,97		crystals			- may cause cancer - may cause heritable genetic damage - may impair fertility - may cause harm to the unborn child - harmful in contact with skin - toxic if swallowed - very toxic if inhaled - causes burns - may cause sensitisation by inhalation or skin contact - toxic: danger of serious damage to health by prolonged exposure through inhalation.	- severe hazard to water	- R-phrase: 45-46-60-61-21-25-26-34-42/43-48/23-50/53		4
Expanding aids	Aluminium				powder							

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
Dispersion powder												
	Vinyl acetate, homo- und co-polymers, co-polymerisates, acrylate-basis or pure acrylate											10
	Polyvinyl acetate	9003-20-7	to 400000		thermoplastic						- binder	4
	Styrene-butadiene-co-polymer	9003-55-8	158.2426						- low hazard to water		- binder	4
	Ethylene-vinyl acetate-co-polymers	24937-78-8			colourless pellets						- binder	4 10
	Melamine-naphthalene sul-fonate											
Anti-freezing agents												
	Micro silica additions											
	Calcium carbonate	471-34-1	100,09		powder			- irritatory to eyes, respiratory system and skin	- no hazard to water	- R-phrase: 36/37/38	- food industry	4
	Sodium carbonate	497-19-8	105,99		crystals			- irritant to eyes	- low hazard to water	- R-phrase: 36		4
	(Calciumnitrite) Sodium nitrite	7632-00-0	69,00		crystals, grains or powder			- contact with combustible material may cause fire - toxic if swallowed - very toxic for aquatic organisms	- hazard to water	- R-phrase: 8-25-50	- textile industry (dying)	4
	Sodium metaaluminate	1302-42-7	81,97	17 (24 °C)	liquid			- causes burns	- low hazard to water	- R-phrase: 34	- paper manufacture	4 32
Admixtures for Mortars												
Setting retarders												
	Dipropylenglycoldiacrylate	34590-94-8	148,20	0,47 (20 °C) 0,48 (25 °C)	liquid			- irritatory to eyes and skin	- low hazard to water	- R-phrase: 36/38	- emulsifier	4 5
	Tripropylenglycoldiacrylate	42978-66-5	300,25					- irritatory to eyes, respiratory system and skin - may cause sensi-		- R-phrase: 36/37/38-43-51/53		5

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								tisation by skin contact - toxic for aquatic organisms, may cause long-term adverse effect in the aquatic environment				
	Acrylamidomethylpropansulfonic acid	15214-89-8	207,24					- harmful if swallowed - irritatory to eyes, respiratory system and skin		- R-phrase: 22-36/37/38		4 5
	Acrylic acid ethyl ester	140-88-5	100,12	39 (20 °C)	liquid			- highly flammable - harmful by inhalation, if swallowed and in contact with skin - irritatory to eyes, respiratory system and skin - may cause sensitisation by skin contact	- hazard to water - easily biodegradable	- R-phrase: 11-20/21/22-36/37/38-43		4 5
	Protein hydrolysates with formaldehyde											
	Polymers with succinyl units											
	Tartaric acid	87-69-4	150,09		crystals			- irritant to eyes, respiratory system and skin		- R-phrase: 36/37/38		4 6
Screed setting retarders	Monoethanolamine	141-43-5	61,08	0,53 (20 °C)	hygroscopic liquid			- harmful by inhalation, if swallowed and in contact with skin - causes burns	- low hazard to water	- R-phrase: 20/21/22-34		3
Admixtures for concrete												
Release agents												
Mineral oils	Paraffinic, naphthenic und aromatic hydrocarbons								- low hazard to water			29
	Naphta	64742-48-9		0,35-12 (20°C)	liquid			- may cause cancer		-R-phrase: 45-65		3 4

Substance(group)	Chemical Constituents	CAS-Number	Molar Weight g/mol	Vapour Press. hPa	Quality	% Additive	% Product	Toxicology	Hazard to Water	Labelling	Further Uses	Source
								- harmful: may cause damage to lung if swallowed				29
Synthetic oils	Parraffinic base oils, contaminsations get hydrogenated								- low hazard to water - biodegradable 80%			29
Vegetable oils	- Rapseed oil - Soya oil - Coconut oil - Palm kernel oil - Sun flower oil								- no hazard to water			29
Derivates from vegetable oils	interesterificated vegetable oil								- low hazard to water			29
	Cocos oil aminoleate	85480-36-0										3
Waxes	- Natural waxes - Modified waxes - Synthetic waxes				among others, powder				- low hazard to water - no hazard to water			29
Resins	colophony (abietic acid)	(514-10-3)	(302,46)		crystals			- irritatory to eyes, respiratory system and skin	- unsaponised resins: low hazard to water - saponised resins in watery solution: hazard to water	- R-phrase: 36/37/38		4 29 32
	Synthetic resins, epoxic resin, polyester resin, acrylic resin, phenolic resin)											29
	- Hydrocarbon resins (petroleum derivates) - Isobutylen polymerisates											
Tensides (see air entraining agents)												

Sources used in the tables:

[1] www.otto-dille.de/pdfs/otto_dille_safety_n18.pdf

[2] http://enius.de/schadstoffe/acrylsaeureethylester.html

[3] http://www.woermann.com/MBTWoermann_De/Products/default.htm
[4] http://www.oekopro.de
[5] Europäische Patentanmeldung EP 1270530 A1
[6] http://www.umwelt-schweiz.ch/imperia/md/content/stobobio/stoffe/6.pdf
[7] http://www.baustoffchemie.de/fachartikel.html
[8] http://www.innob.de/start/start.htm?../docs/fuellstoffe.html~main
[9] http://www.uppc.de/deutsch/matrix_engine/content.php?page_id=75
[10] http://www.nrc.de/
[11] http://www.ctpgmbh.de/html/produkte_1_d.htm
[12] http://webmineral.com/data/Palygorskite.shtml
[13] http://baua.de
[14] www.phoschek.com/shared/content_objects/ product_objects/PHOS-CHEK_259F259R259W.pdf
[15] http://www.chempage.de
[16] www.gisbau.de/service/epoxi/EpoxidharzWorkshop.pdf
[17]http://www.gischem.de/e5_prod/dokart_kompl.htm?view_search_Textblock_ObjektTexteOID_EQ=873&view_search_Textblock_Verarbeitung_EQ=220&view_search_Textblock_DokumentArt_EQ=Datenblatt+f%FCr+Unternehmer%2FFASI%2FBetriebsrat&view_search_order1=Textblock_WBSortierung&view_search_order2=Textblock_TBSortierung&view_Objekt_OID=873&client_request_prevpage=dokart.htm&client_session_TB4741=1
[18] http://www.mst.dk/homepage/default.asp?Sub=http://www.mst.dk/udgiv/publications/2004/87-7614-181-0/html/kap05_eng.htm
[19] www.emsdiasum.com/microscopy/technical/msds/13600.pdf
[20] http://www.filtrox.ch/filtrox-gbs-en/kieselgur.htm
[21] http://www.sto.at
[22] http://www.bayferrox.bayerchemicals.de/bayer/chemicals/ipg.nsf/(CUS_SDBDocLookupWeb)/0282CC6F216E8DC4C1256F3F001CE258/$file/Chromoxidgrün_GN-M_1481114236_D.pdf
[23] http://www.kremer-pigmente.de
[24] http://www.munzing-chemie.de
[25] http://www.mc-bauchemie.de
[26] Deutsche Bauchemie e.V.; BetonAdmixtures und Umwelt Sachstandsbericht mai 1999; Baucom Verlag for Marketing und Kommunikation; Böhl-Iggelheim 1999
[27] Brameshuber; Vollpracht; Institut for Bauforschung R OPH Aachen; Erarbeitung eines Grundsatzpapiers zur Feststellung der Umweltverträglichkeit von genormten Betonausgangsstoffen – Forschungsbericht Nr. F 836; Aachen 2002
[28] Deutsche Bauchemie e.V.; Hydrophobierung und Umwelt Sachstandsbericht April 2001; Baucom Verlag for Marketing und Kommunikation; Böhl-Iggelheim 2001
[29] Bauchemie e.V.; Betontrennmittel und Umwelt Sachstandsbericht Juni 2001; Baucom Verlag for Marketing und Kommunikation; Böhl-Iggelheim 2001
[30] http://www.umweltbundesamt.de
[31] www.syngenta-agro.de/syngenta_infos/ pdf_dateien/prd_sd/sd_ortiva.pdf - 19. Sept. 2005 –
[32] http://biade.itrust.de/biade/lpext.dll?f=templates&fn=main-hit-h.htm&2.0
[33] http://www.gefahrstoff-info.de
[34] www.chemical-check.de/clientversion/ pdf1/514/0893-080-120-I_0002_10-11-2003_DE.pdf
http://www.salzgitter-aktuell.de/dynasite.cfm?dssid=3193
http://www.syskem.de
http://enius.de/schadstoffe/mci.html

References

Achternbosch M., Bräutigam K.-R., Hartlieb N., Kupsch C., Stemmermann P., Richers U. (2003): Untersuchung des Einflusses der Mitverbrennung von Abfällen in Zementwerken auf die Schwermetallbelastung des Produktes in Hinblick auf die Zulässigkeit der Abfallverwertung. Kurzfassung. Institut für Technikfolgenabschätzung und Systemanalyse. In cooperation with Institut für Technische Chemie. Karlsruhe.

AgBB (2004): 2. Fachgespräch zur Vorgehensweise bei der gesundheitlichen Bewertung der Emissionen von flüchtigen organischen Verbindungen (VOC) aus Bauprodukten. 25. November 2004. Bericht. Ausschuss zur gesundheitlichen Bewertung von Bauprodukten. In cooperation withUmweltbundesamt and Deutsches Institut für Bautechnik. Berlin.

AgBB (2005): Vorgehensweise bei der gesundheitlichen Bewertung der Emissionen von flüchtigen organischen Verbindungen (VOC nd SVOC) aus Bauprodukten. Ausschuss zur gesundheitlichen Bewertung von Bauprodukten. Berlin.

ARGEBAU (2002): MBO. Musterbauordnung Fassung November 2002. BauministerkonferenzKonferenz der für Städtebau, Bau und Wohnungswesenzuständigen Minister und Senatoren der Länder.

BKS (2003): Totalproduktion Baukies und Bausand 2000. Bundesverband der Deutschen Kies- und Sandindustrie e.V. http://bks-info.de .

BMU (2000): Gammaspektrometrische Bestimmung ausgewählter natürlicher Radionuklide. In: Messanleitungen für die Überwachung der Radioaktivität in der Umwelt und zur Erfassung radioaktiver Emissionen aus kerntechnsichen Anlagen. Der Bundesminister für Umwelt, Naturschutz und Reaktorsicherheit (Hrsg.). Elsevier Urban Verlag.

BMU (2006): Gammaspektrometrische Bestimmung der spezifischen Aktivität von Radionukliden in Boden. In: Messanleitungen für die Überwachung der Radioaktivität in der Umwelt und zur Erfassung radioaktiver Emissionen aus kerntechnsichen Anlagen. Der Bundesminister für Umwelt, Naturschutz und Reaktorsicherheit. (Hrsg.). Elsevier Urban Verlag. München.

BMVBW (1998): Allgemeines Rundschreiben Strassenbau Nr. 18/1998 Zement fuer den Bau von Fahrbahndecken aus Beton (Strassenbauzemente). Bundesministerium für Verkehr, Bau und Wohnungswesen.

Brameshuber W., Uebachs S. (2000): Freisetzung von umweltrelevanten organischen Bestandteilen aus Betonen mit Betonzusatzmitteln - Abschlussbericht - Forschungsbericht F587. Forschungsbericht F587. Institut für Bauforschung RWTH Aachen. Aachen.

Brameshuber W., Vollpracht A. (2003): Erarbeitung eines Grundsatzpapiers zur Feststellung der Umweltverträglichkeit von genormten Betonausgangsstoffen. Forschungsbericht F 836. Institut für Bauforschung Aachen (ibac). Aachen.

Breuer, Scherer (2005): Querschnittsuntersuchung zum Emissionspotential an flüchtigen organischen Verbindungen von mineralischen Putzen und Werkmörteln des Wohninnenraums und zur Ermittlung von Eluationsraten von beregneten mineralischen Putzen und Werkmörteln in der Außenanwendung. Forschungsvorschlag im Auftrag des Industrieverbands Werkmörtel. Fraunhofer Institut für Bauphysik.

Bundesverband der Gipsindustrie e.V. (2003): Gips-Datenbuch. www.gipsindustrie.de Darmstadt.

CEN (1999a): prEN 13419-1. Building products - Determination of the emission of volatile organic compounds - Part 1: Emission test chamber method. European Committee for Standardisation.

CEN (1999b): prEN 13419-2. Building products - Determination of the emission of volatile organic compounds - Part 2: Emission test cell method. European Committee for Standardisation.

CEN (1999c): prEN 13419-3. Building products - Determination of the emission of volatile organic compounds - Part 3: Procedure for sampling, storage of samples and preparation of test specimens. European Committee for Standardisation.

CEN (2004): EN 197-1. Zement - Teil 1: Zusammensetzung, Anforderungen und Konformitätskriterien von Normalzement. European Committee for Standardisation.

CEPMC (2005): Industry Overview. Council of European Producers of Materials for Construction. http://www.cepmc.org/

DAfStb (2001): Vorbeugende Maßnahmen gegen schädigende Alkali-Reaktion im Beton. Deutscher Ausschuss für Stahlbeton. Beuth Verlag. Berlin.

DAV (2003): Asphaltproduktion in Deutschland. Deutscher Asphaltverband. http://www.asphalt.de/aktuelles/presse.htm .

Dehoust G., Rheinberger U., Küppers P. (2005): Aufkommen, Qualität und Verbleib mineralischer Abfälle. In Bearbeitung. Öko-Institut e.V. Darmstadt.

DIBt (2005): **Grundsätze zur gesundheitlichen Bewertung von Bauprodukten in Innenräumen**. Deutsches Institut für Bautechnik. Berlin.

DIBt (2006a): **Grundsätze zur Bewertung der Auswirkungen von Bauprodukten auf Boden und Grundwasser**. Deutsches Institut für Bautechnik. Berlin.

DIBt (2006b): Grundsätze Boden und Grundwasser. Grundsätze zur Bewertung der Auswirkungen von Bauprodukten auf Boden und Grundwasser. Deutsches Institut für Bautechnik. Berlin.

Dijkstra J. J., van der Sloot H. A., Spanka G., Thielen G. (2005): How to judge release of dangerous substances from construction products to soil and groundwater. Endbericht im Auftrag des Umweltbundesamtes. ECN Clean Fossil Fuels. In cooperation with VDZ Verband der deutschen Zementindustrie.

DIN (1984): DEV S4. DIN 38414-4 Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Schlamm und Sedimente (Gruppe S); Bestimmung der Eluierbarkeit mit Wasser (S 4).(German standard methods for the examination of water, waste water and sludge; sludge and sediments (group S); determination of leachability by water (S 4)). Deutsches Institut für Normung. Berlin.

DIN (2002): VOB/C. Vergabe- und Vertragsordnung für Bauleistungen - Teil C: Allgemeine Technische Vertragsbedingungen für Bauleistungen (ATV); Allgemeine Regeln

für Bauarbeiten jeder Art rdingungsordnung für Bauleistungen. Deutsches Institut für Normung. Berlin.

Drosser T. (2005): Thema: Gips. Journal Mittelstand 10. Januar 2005. Handelsblatt.

Eberle H. S., Rudek R. (2003): Der Förderschwerpunkt "Sickerwasserprognose" des BMFT und des BMU/UBA. Konzept und erste Ergebnisse. Zwischenbericht. Heinrich-Sontheimer-Laboratorium DVGW-Technologiezentrum Wasser.

EC (2003): Guidance Paper G. Guidance Paper G (concerning the Construction Products Directive) The European Classification System for the Reaction to fire performance of Construction Products. European Commission Enterprise Directorate-General. Brussels.

EC (2004): EGF 353 CWFT 081 REV 1 Construct 01/491 REV 3. Classification of products of known and stable performance. Procedural aspects. Draft June 2004. European Commission Enterprise Directorate-General. Brussels.

EC (2006a): 2003/43/EG. Entscheidung der Kommission vom 17. Januar 2003 zur Festlegung der Brandverhaltensklassen für bestimmte Bauprodukte. Abl. EG L 13 vom 18.1.2003. 25

EC (2006b): Mandat M/366. Horizontale Ergänzung zu den Aufträgen an CEN/CENELEC betreffend die Ausführung von Normungsarbeit für die Entwicklung horizontaler genormter Bewertungsmethoden für harmonisierte Konzepte zu gefährlichen Stoffen gemäß der Bauproduktenrichtlinie (Construction Products Directive) – Emission in Raumluft, Boden, Oberflächenwasser und Grundwasser. Europäische Kommission Generaldirektion Unternehmen und Industrie, Baugewerbe. Brüssel.

EG (1989): BPR. Richtlinie des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschiften der Mitgliedstaaten über Bauprodukte (89/106/EWG) geändert durch die Richtlinie 93/68/EWG des Rates vom 22. Juli 1993. EG-Amtsblatt Nr. L 40 vom 11.2.1989, S.12 und Nr. L 220 vom 30.8.1993, S.1.

Ehrnsperger R., Misch.W. (2005): Gesundheits- und Umweltkriterien bei der Umsetzung der EG-Bauprodukten-Richtlinie (BPR). UBA Texte 06/05. Umweltbundesamt. Berlin. (Also available in English as UBA-Texte 14/06.)

Eurogypsum (2005): REA-Gips - Qualitätskriterien und Analysemethoden. Verband der Europäischen Gipsindustrien, ecoba und VGB.
http://www.gips.de/industrie/bvg/publik/rea-eur/FGD-Gypsum.pdf.

FGSV (1994): Merkblatt über die Verfestigung von Waschbergen aus der Steinkohlengewinnung mit hydraulischen Bindemitteln. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (1995): TL WB-StB 95. Technische Lieferbedingungen für Waschberge aus der Steinkohlengewinnung als Baustoffe im Straßen- und Erdbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (1998a): Merkblatt über die Verwendung von Hüttenmineralstoffgemischen, sekundärmetallurgischen Schlacken sowie Edelstahlschlacken im Straßenbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (1998b): Merkblatt zur Wiederverwendung von Beton aus Fahrbahndecken. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (1999a): Merkblatt über die Verwendung von Metallhüttenschlacken im Straßenbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (1999b): TP Min-StB 1999. Technische Prüfvorschriften für Mineralstoffe im Straßenbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2000): MVAG. Merkblatt für die Verwertung von Asphaltgranulat. Forschungsgesellschaft für Strassen- und Verkehrswesen.

FGSV (2001a): RuA-StB 01. Richtlinien für die umweltverträgliche Anwendung von industriellen Nebenprodukten und Recycling-Baustoffen im Straßenbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2001b): RuVA-StB. Richtlinien für die umweltverträgliche Verwertung von Ausbaustoffen mit teer-/pechtypischen Bestandteilen sowie für die Verwertung von Ausbauasphalt im Straßenbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2001c): TL AG-StB. Technische Lieferbedingungen für Asphaltgranulat. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2002a): FGSV-Gremien. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2002b): Merkblatt über die Verwendung mineralischer Baustoffe aus Bergbautätigkeiten im Straßen- und Erdbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2002c): RiStWag. Richtlinien und bautechnische Maßnahmen an Straßen in Wasserschutzgebieten. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2003): Hinweise zur Verwendung von Braunkohlenflugasche aus Kraftwerken mit Kohlenstaubfeuerung im Erdbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2004a): TL Gestein-StB 2004. Technische Lieferbedingungen für Gesteinskörnungen im Straßenbau. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2004b): TL SoB-StB 04. Technische Lieferbedingungen für Baustoffgemische und Böden zur Herstellung von Schichten ohne Bindemittel. Forschungsgesellschaft für Strassen- und Verkehrswesen. Köln.

FGSV (2005): TL G Asphalt-StB 01. Technische Lieferbedingungen für Asphalt im Straßenbau - Teil: Güteüberwachung - mit Einarbeitung der Änderungen aus ARS Nr. 9/2005.

FGSV (2006a): TL Pflaster-StB 06. Technische Lieferbedingungen für Bauprodukte zur Herstellung von Pflasterdecken, Plattenbelägen und Einfassungen.

FGSV (2006b): TL Beton - StB 06. Technische Lieferbedingungen für Baustoffe und Baustoffgemische für Tragschichten mit hydraulischen Bindemitteln und Fahrbahndecken aus Beton (noch nicht erschienen).

Ausgabe 2006FhI (2006): Entwicklung und Überprüfung eines vereinfachten Verfahrens zur Fremdüberwachung und zur werkseigenen Produktionskontrolle von VOC/SVOC-Emissionen im Rahmen der gesundheitlichen Bewertung von Innenraumbauprodukten. In Bearbeitung. Fraunhofer Institut für Bauphysik. HolzkirchenFraunhofer Institut für Bauphysik, Institutsteil Holzkirchen.

Gellert R. (2006): "Entwicklung eines ITT-Prüfverfahrens zur Bestimmung der Emission gefährlicher Substanzen aus Dämmstoffen". Kurzbericht. Forschungsinstitut für Wärmeschutz e.V. München. München.

Glatthor A. (2005a): Baustoffchemie - Chemie der Werkstoffe im Bauwesen - Dünnlagenputz auf Gipsbasis.
http://www.baustoffchemie.de/richtrezepturen/Dünnlagenputz_auf_Gipsbasis_2002.html .

Glatthor A. (2005b): Baustoffchemie - Chemie der Werkstoffe im Bauwesen - Gipsleichtputz, maschinengängig.
http://www.baustoffchemie.de/richtrezepturen/Gipsleichtputz_1984.html .

Glöckner M. (7/10/2005): Deutsche Bauchemie. Persöngliches Gespräch vom 7.10.2005.

Goetz D. (1990): Prüfung der Umweltverträglichkeit von Straßenbaustoffen. Forschungsbericht 90-103 01 369. Institut für Bodenkunde Universität Hamburg.

Hildebrand M. (22/4/2005): St.-Gobain Weber GmbH. Persönliche Mitteilung im Workshop Putze und Mörtel am 21.4.2005.

Hohberg I. (2003): Charakterisierung, Modellierung und Bewertung des Auslaugverhaltens umweltrelevanter, anorganischer Stoffe aus zementgebundenen Baustoffen. Deutscher Ausschuss für Stahlbeton DAfStb (Hrsg.). Berlin.

Horn W. (2005): Ermittlung von Emissionen aus Fertigputzen und Auswertung nach dem AgBB-Schema. Auftaktworkshop "Products without further testing - Putze und Mörtel" des Öko-Instituts.

ISO (1997): ISO GUIDE 64. Guide for the inclusion of environmental aspects in product standards. International Standard Organisation. Genf.

ISO (2004a): ISO 16000-3. Indoor air – Part 3: Determination of formaldehyde and other carbonyl compounds; Active sampling method. International Standard Organisation. Genf.

ISO (2004b): ISO 16000-6. Indoor air - Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and gas chromatography using MS/FID. International Standard Organisation. Genf.

Jenseit W. (2003): Materialaufwand der Verkehrsinfrastrukturen in Deutschland. Unveröffentlicht im Auftrag des Statistischen Bundesamtes Wiesbaden. Öko-Institut e.V. Freiburg, Darmstadt, Berlin.

Johnke B. (15/12/2003): Umweltbundesamt. Persönliche Mitteilung.

Krass K. (2000): Neugestaltung der Technischen Regelwerke des Straßenbaus durch Einbeziehung der Europäischen Normen (EN). In: Straße + Autobahn /1 . S. 58-64.

Krass K., Jungfeld I., Trogisch H. (2002): Anfall, Aufbereitung und Verwertung von Recycling-Baustoffen und industriellen Nebenprodukten im Wirtschaftsjahr 1999 - Teil 2: Industrielle Nebenprodukte. In: Straße + Autobahn 2002/2 . S. 86-92.

KWTB (2003): 3. Monitoring-Bericht Bauabfälle. Arbeitsgemeinschaft Kreislaufwirtschaftsträger Bau.

LAGA (1998): Anforderungen an die stoffliche Verwertung von mineralischen Reststoffen/Abfällen - Technische Regeln - Stand 6.11.1997. Länderarbeitsgemeinschaft Abfall. Erich Schmidt Verlag. Berlin.

LAGA (2004): **TR Boden**. **Anforderungen an die stoffliche Verwertung von mineralischen Abfällen:**
Teil II: Technische Regeln für die Verwertung
1.2 Bodenmaterial (TR Boden) Stand 5.11.2004. Länderarbeitsgemeinschaft Abfall.

LAWA (2002): Grundsätze des vorsorgenden Grundwasserschutzes bei Abfallverwertung und Produkteinsatz (GAP-Papier). Länderarbeitsgemeinschaft Wasser. Hannover.

LAWA (2003): Hearing Geringfügigkeitsschwellenwerte für das Grundwasser 20.11.2003. Länderarbeitsgemeinschaft Wasser - Unterausschuss Geringfügigkeitsschwellen. Berlin.

Leuchs W., Delschen T., Bertram H.-U., Koch D., Zerbe H.-D., Bannick C. G. (2003): Ableitung von Eluatwerten für die Verwertung von Bodenmaterial als Schüttgut - Konzept und Vorschläge für Zordnungswerte.

Lüth P., De Alwis D. T., Kirchhoff R. M. (1999): Experimentelle Ermittlung des Emissionsverhaltens flüchtiger organischer Verbindungen aus Baustoffen als Grundlage für die medizinische Begutachtung. Zentrum für Human- und Gesundheitswissenschaften der Berliner Hochschulmedizin. Berlin.

Mederer J., Hindel R., Rosenberg F., Linhard E., Martin M. (1998): Geologisches Jahrbuch - UAG "Hintergrundwerte" der Ad-hoc-AG Geochemie - Statusbericht Dezember 1996 - Reihe G, Heft 8. Bundesanstalt für Geowissenschaften und Rohstoffe (Hrsg.). E.Schweizerbart´sche Verlagsbuchhandlung. Hannover.

Merkel Th. (2003a): Erhebungen zur Erzeugung und Nutzung von Eisenhüttenschlacken 2002. In: FEhS Report des Forschungsinstituts für Eisenhüttenschlacken 2003/1 . S. 1-2. Duisburg.

Merkel Th. (16/12/2003b): FEhs - Forschungsgemeinschaft Eisenhüttenschlacken. Persönliche Mitteilung vom 16.12.2003.

ODPM Office of the Deputy Prime Minister, Creating sustainable communities (2005): Regulatory impact assessment. Annex B: Costs for Fire Testing and Re-Engineering Construction Products. http://www.odpm.gov.uk/index.asp?id=1130979 . United Kingdom.

ÖN (1996): ÖN S 5200. Österreichisches Normungsinstitut. Wien.

Oregon (2003): Environmental Impact of Construction and Repair materials on Surface and Groundwaters. Department of Civil, Construciton and Environmental Engineering Oregon State University.

Östmann B., Mikkola E. (2006): European Reaction to fire performance of wood and timber products. http://ans.hsh.no/if/brann/InterFlam/InterFlam%2004/files/35.pdf .

quick-mix (2005): Kalk-Maschienenputz MK E Technische Informationen. http://www.quick-mix.de/TI-MKE.pdf .

Rosenkranz U. (2003): Der Zementverbrauch im Tiefbau. InformationsZentrum Beton GmbH. Köln. http://www.bdzement.de/download/literatur/mafo/ZV_Tiefb.pdf.

Umweltbundesamt (2006): Kommission Innenraumlufthygiene (IRK). http://www.umweltbundesamt.de/uba-info-daten/daten/irk.htm#4 .

Vollpracht A. (2002): Entwicklungen im Betonstrassenbau in Deutschland. update Aktuelles zum Thema Betonstrassen [2]. BDZ, Bundesverband der Deutschen Zementindustrie e.V.

vom Berg (16/12/2003): VGB Powertech e.V. Persönliche Mitteilung vom 16.12.2003.

von Arx U. (1999): Bauprodukte und Inhaltsstoffe. Bundesamt für Umwelt, Wald und Landschaft (BUWAL). Bern.

Voß L., Marquordt D. (2001): Rohstoffe für den Straßen- und Brückenbau in Sachsen-Anhalt. In: Mineralstoffe im Straßenbau. Vorträge der FGSV-Tagung am 23. und 24. März 2000 in Magdeburg. 9-17. Forschungsgesellschaft für Strassen- und Verkehrswesen (Hrsg.). Kirschbaum Verlag. Bonn.

Weßelborg H. (2003): Umsetzung der Europäischen Normen in ein zweiteiliges nationales Regelwerk - Grundsätze. In: Mineralstoffe im Straßenbau - Vorträge der FGSV-Tagung am 2. und 3. Dezember 2003 in Köln. Schriftenreihe der Arbeitsgruppe "Mineralstoffe im Straßenbau". Forschungsgesellschaft für Straßen- und Verkehrswesen Köln (Hrsg.). Kirschbaum Verlag. Bonn.

Zellweger C., Hill M., Gehrig R., Hofer P. (1997): Schadstoffemmisionsverhalten von Baustoffen. Bundesamt für Energie. Bern.