

## The success story of earth building standards in Germany

Earth building materials have become a normal and modern choice in German building practice and their use has risen steadily in recent years. A key reason for both these developments is that they are regulated by rules and standards, enabling architects, engineers and artisans to use and specify earth building materials without undue risk. These standardised building materials are now used widely in both new construction and in conservation work.

The first set of building codes for earth building materials was published as the *Lehmbau Regeln* in 1998. The first series of official *DIN standards* on earth building materials, based on a subset of the earlier codes, were published in 2013. The current second generation of earth building DIN standards were published in December 2018 and revise, restructure and expand the existing norms to cover further earth building products. Work is already underway on the third generation of standards, which will include new structural design concepts for earth block structures.

German standards for earth building materials serve as a model for standardisation work in other countries. In France, for example, a standard for earth blocks is currently being developed based on the corresponding German standard. It is, however, too soon to talk of the creation of uniform European standards as too few European countries have initiated the development of regulations for earth building materials and construction.

The purpose and necessity of rules and regulations for earth building was debated at length by the members of the Dachverband Lehm e.V., the German Federal Association for Earth Building, immediately after its foundation in 1992. The consensus was that the goal of promoting the application of earth building cannot be achieved by the internal exchange of information

alone but that specialist information on earth building should be available to everyone in the form of regulations. Keen proponents of earth building will be prepared to take a higher risk and overcome difficulties in the planning process through greater personal commitment and diligence in the planning and building process. While this attitude can be seen as selfless and idealistic, it is ultimately also selfish in that, without the general availability of knowledge, only the experts are able to navigate the additional hurdles of so-called 'unregulated' construction. The Dachverband Lehm e.V. has therefore always advocated the development of regulations for earth building materials and this has contributed significantly to the more widespread adoption and recognition of earth building in Germany, which is seen as a model for earth building around the world.

Among the concerns voiced during the early debates was that rules and regulations in earth building:

- limit creativity in the planning and construction process,
- restrict the usability of locally sourced earth, or
- disadvantage small-scale manufacturers of earth building materials as the cost of testing building materials is disproportionately high.

In an attempt to mitigate these concerns, they were taken into account in the wording and clauses of the regulations, and today general acceptance of the regulations is very high.

### **Regulations for earth building materials in Germany –Development and current state**

In 1996, the German Institute for Building Technology (DIBt) approached the Dachverband Lehm e.V. with the proposal to formulate a new set of building regulations for earth building materials. Two years later, the first set of rules for earth building, the so-called

*Lehmbau Regeln*, was published [1]. They cover all earth building methods and materials and outline each with a short description. As official building regulations, the *Lehmbau Regeln* are recognised by the federal building authorities and form the legal basis for building with earth in Germany. The third edition is currently valid. According to the regulations, non-loadbearing construction with earthen materials such as plaster and clay boards is permitted in all building categories and all heights of buildings. Loadbearing earth building materials may be used in constructions no taller than two storeys. Where loadbearing earth building materials are used in taller constructions, an exception in the form of a "special approval in individual case" must be obtained from the planning authorities.

The short descriptions of all earth building materials and building methods in the *Lehmbau Regeln* are, however, not detailed enough for the specific requirements of the building industry. The Dachverband Lehm e.V. therefore decided to continue their standardisation efforts as follows:

- DIN standards should be developed for the most important prefabricated earth building materials.
- DIN standards will not be developed for less important prefabricated earth building materials and their application as this would be unreasonably expensive. For these materials, so-called Technical Datasheets will be elaborated that are essentially just as detailed as the norms but have not undergone the complex and expensive procedure of becoming a standard. As a set of technical rules published by a federal professional association, the technical data sheets belong to the so-called generally recognised rules of construction engineering in Germany [2] [3].
- The *Lehmbau Regeln* will be shortened to cover only those materials and building methods not governed by the DIN standards or Technical Datasheets. Essentially, the *Lehmbau Regeln* now primarily cover building with local earth resources and buildings techniques used in historical building conservation. This revision of the *Lehmbau Regeln* is still pending.

In August 2013, the first generation of new DIN standards for earth building materials – authored by the DIN Working Committee NA 005-06-08 AA *Lehmbau* – was adopted and published. These were:

- DIN 18945:2013-08 Earth blocks – Terms and definitions, requirements, test methods
- DIN 18946:2013-08 Earth mortar for masonry – Terms and definitions, requirements, test methods
- DIN 18947:2013-08 Earth mortar for plasters – Terms and definitions, requirements, test methods.

The primary goal of the DIN standards for earth building materials is to ensure material stability and performance. Additional goals included incorporating softer ecological criteria such as the establishment of procedures to determine CO<sub>2</sub>-equivalent characteristic values or parameters affecting the indoor environment such as water vapour sorption capacity. Natural radioactivity values, which needs to be declared for all mineral construction materials, have also been incorporated at a very low prevention guidance level in accordance with European legislation as well as critical user expectations.

The DIN standards are now well established in the daily work and design processes of architects and engineers. In addition, earth building product producers have adopted and applied the testing procedures and declaration systems and to date there has been no significant criticism of the standards, whether in general or in detail.

The number of cases of damage caused by unsatisfactory products has also decreased significantly since the standards were published.

In Germany, regulations must be revised every five years to meet current developments. As a result, the first generation of DIN standards from 2013 was revised and published as the second generation in 2018. The following changes and additions were made:

- The description of terms contained in each of the existing technical standards were separated out into a new, single terminology standard: DIN 18942-1.
- Similarly, the conformity assessment procedures from each of the existing standards was separated out into a new conformity assessment standard: DIN 18942-100.
- Only minor changes were made to the main content of the standards for earth blocks, earth masonry mortar and earth plaster mortar, as the existing standards have proved useful and practicable in everyday practice.

- A new DIN standard was developed for earthen boards to reflect the considerable growth and advancements in this product sector: DIN 18948.

As a result, the currently valid standards for earth building are:

- DIN 18942-1: 2018-12 Earthen materials and products – Part 1: Vocabulary
- DIN 18942-100: 2018-12 Earthen materials and products – Part 100: Conformity assessment
- DIN 18945: 2018-12 Earth blocks – Requirements, test and labelling
- DIN 18946: 2018-12 Earth masonry mortar – Requirements, test and labelling
- DIN 18947: 2018-12 Earth plasters – Requirements, test and labelling
- DIN 18948: 2018-12 Earthen boards – Requirements, test and labelling.

Not covered by the Lehm bau Regeln or the DIN standards for earth building are earth building materials that consist of earth or clay with other binders, such as gypsum, lime or cement. Such stabilised earth building materials do not comply with the Lehm bau Regeln or the DIN standards for earth building in Germany.

### Outlook

The level of regulation in the field of earth building in Germany has developed well and is currently better than in any other country in the world. However, it is still not at a level that allows unhindered planning and building with earth building materials. Standardisation therefore remains a high priority for the Dachverband Lehm e.V. in the coming years.

Work is already underway on a third generation of DIN standards with special focus on the development of a new structural design concept for earth block structures. For example, experimental proposals for partial safety factors on the material side for earth blocks and earth masonry mortar are currently being developed. Depending on the application of earth blocks, these are exposed to different moisture influences. Since the strength of earth building materials depends on moisture content, factors for the consideration of moisture must be assigned to the respective area of application, as seen, for example, in wood building materials. Further tests are currently also taking place to determine reliable values for long-term strength and creep in structural design.

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The English translation of the standards originally planned for 2020 has been postponed until the establishment of the new third generation, probably in 2023.

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