Product Data Templates of Repair Products for Building Information Modeling (BIM)

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Abstract. Building Information Modeling (BIM) describes the digital and collaborative planning, construction and management of buildings by all stakeholders by means of a digital 3D building (data) model. This enables complex analyses, simulations and optimizations of cost, time and quality. For these reasons, BIM is becoming increasingly important in the construction industry and brings changes along the entire “construction value chain”. Such changing and unclear (data) requirements are major challenges for the manufacturers of construction chemicals, e.g. for products for "Concrete Repair and Protection". As harmonized standards are still lacking and a wide variety of concepts are available on the market today. Therefore, demand-oriented BIM product data templates for two pilot groups of construction chemicals products were developed by the German association of manufacturers of construction chemical products (Deutsche Bauchemie e. V.). With all parties involved in the process, from planning to construction, the information requirements were recorded. Furthermore, characteristics were defined using existing standards and structured in an extensive list of characteristics. In addition, software templates were created in native but also in open file formats. The development of further lists of characteristics is currently in preparation, in addition to other product groups, also for repair mortars and other repair products.

1 Background

Building Information Modeling (BIM) is becoming increasingly important in the construction industry and brings changes in roles and processes along the entire “construction value chain”. Such changing and unclear (data) requirements are major challenges for the manufacturers of construction chemicals, e.g. for products for "Concrete Repair and Protection". As harmonized standards are still lacking and a wide variety of software solutions and data concepts are available on the market today. Therefore, the German association of manufacturers of construction chemical products (Deutsche Bauchemie e. V.) decided to develop demand-oriented BIM product data templates for construction chemicals.

2 Basic knowledge

2.1 Definition

Building Information Modeling (BIM) is a cooperative working methodology that, based on digital models of a building, consistently captures, manages and exchanges the information and data relevant to its life cycle in transparent communication between stakeholders or is handed over for further processing [1].

In this context, the construction product data is also becoming increasingly important.

2.2 Drivers

Although, for example, in Germany, many construction projects are currently being implemented, statistics show great potential of the construction industry for improvement in terms of cost, time and quality of the construction projects. In detail e.g., the productivity per hour worked in the German construction industry is extremely low compared to the economy as a whole [2].

![Fig. 1. Labour productivity per hour worked in Germany in comparison 1991 – 2018 (index value 1991=100) [2]](image)

According to numerous studies, large construction projects regularly exceed the schedule by about 20% and often result in additional costs of up to 80% of the calculated construction costs. Therefore, politicians, construction stakeholders and clients are increasingly pushing for the use of BIM.
In addition, sustainability certification bodies as well as investors are also in favour of the improved data basis for the automatic assessment of buildings through BIM.

Even operators require more and more the use of BIM, as 80% of the life cycle costs are incurred during the operating phase of a building and BIM enables large savings through operationally optimised planning.

In this life cycle phase products for "Concrete Repair and Protection" and their data are getting relevant, too.

The manufacturers of building products themselves also benefit from BIM. Earlier and more detailed planning of the construction, operation and demolition phase results in new support potential and new target groups for manufacturers.

2.3 Challenges for product manufacturers

One of the biggest difficulties regarding BIM for product manufacturers is the lack of standards. This results in a variety of software solutions, data formats and object libraries on which manufacturers can offer their BIM objects. These many approaches are mostly incompatible individual solutions and proprietary formats. Open formats such as IFC are often limited in their functionality. Overall, this makes it difficult to fully exchange data between different software systems.

For manufacturers, this results in disorientation due to the oversupply of solutions and a lack of know-how on user needs and market requirements, as well as a large number of BIM objects to be created and maintained per product. The product data templates for construction chemicals are a first solution approach here.

2.4 BIM object

A BIM object represents a real product or component in the digital building model. The BIM object can contain three types of information:

The geometry of the product isn’t that important regarding the two-dimensional construction chemicals. They often do without their own geometry and the product information can be attached to other components, such as the floor and are thus a special feature in the visually shaped BIM world.

In addition, unstructured data, such as product catalogs, certifications or application notes, can be linked to the BIM object of a construction product.

The most important aspect of a BIM object is the structured data. These are essential product information which are described by standardized product attributes, such as crack bridging or tensile strength. This information should be machine-readable and uniformly defined because the software must clearly know what is meant by a term so that it can take the corresponding value into account in simulations and calculations. Machine-readable information is also required for correct data exchange with other software systems. However, industry standards are largely lacking for this structured data – so far, each manufacturer provides different data and also names it individually.

3 Product Data Templates for construction chemicals

In order to support the manufacturers of construction chemicals as well as all construction stakeholders in the use of BIM and to create reliable information bases, Deutsche Bauchemie started to develop product data templates. With the active cooperation of a broad base of member companies and the Fraunhofer Institute IBP as project partner, the project was launched in 2018.

The goal was to collect and standardize the information needs of all project stakeholders and define product data templates for the construction chemical product groups throughout the industry and make them available to our member companies and the construction stakeholders. As pilot product groups, tile laying systems with waterproofing kits and car parking deck coatings were selected. In addition, building waterproofings have been processed so far.

Fig. 2. Procedure to generate Product Data Templates for construction chemicals
3.1 Procedure and results

At the beginning of the project, an efficient process was set up in order to develop the product data templates.

The methodologically central elements of the first project phases were workshops. Here, various process stakeholders were involved in order to understand all needs. Specifically, product experts from the member companies, architects, application engineers, along with BIM, marketing and sales experts, as well as recycling and operations specialists were included.

The aim of the first Phase were to properly understand and record the processes and information needs. Therefore, different aspects were considered:

- What characterizes and distinguishes a product?
- Who are the parties to the proceedings?
- Where are the products or information used?
- Which communication media are used to exchange information today?

Based on such questions, the product characteristics emerged as a MindMap and a process map.

Then the relevant data sources got identified and the following information collection and preparation was then the core work: To work out what is current and relevant from standards, fact sheets and data sets. But also to analyse which BIM activities are still taking place in the industry – and to weigh up what influences the project and how.

In the third Phase the findings were collected, structured and optimized in a property list per product group. The list contains, for example:
- the designation of the properties and their definition,
- the source of the designation and the definition,
- the English translations,
- the units,
- possible expressions of the properties,
- information on which stakeholder provides or needs the data.

In addition, the "translations" into the respective software solutions or data formats are listed, e.g. IFC or Revit.

After completion of the workshops and content work, the technical implementation was improved with IT experts in order to promote the dissemination and standardisation of project results. In cooperation with an IT service provider and via the BIM-Software BIMQ the Excel based lists got transformed into BIM compatible formats.

Via the new BIM Portal of Deutsche Bauchemie these results are available for the member companies, so they can share them with there customers. Furthermore the results are shared with several software providers, so they can adapt their properties for the product groups covered.

Further improvements are needed as the process of importing product-specific pre-filled Product Data Sheets without associated three-dimensional geometry is currently not very practical.

4 BIM for “Protection and repair of Concrete structures”

In addition to the product groups covered so far (tile laying systems with waterproofing kits, car parking deck coatings and waterproofing of buildings ), BIM product data templates will also be developed for repair mortars in the future as part of this project. In concrete repair, there are various possible applications and potentials regarding BIM. These are to be supported by the uniform properties in the various phases of planning and execution. [4]

4.1 Creation of the 3D Model

More and more often, clients already have a 3D model of the existing building. Otherwise, the 3D model must be remodelled by the planning office using paper plans and digital 2D plans. In addition, a point cloud of the existing object can be used to verify the data of the remodelling 3D model. The point cloud, generated from hundreds of thousands of individual measurements with modern 3D laser technology, looks like a 3D photograph of the object. Depending on the project, the required and practical level of detail and thus also the creation effort of the model must be determined individually. [4]

4.2 Information enrichment

An important next step is to enrich the 3D model with relevant component attributes and parameters and to link these to the components, such as the concrete quality, the degree of reinforcement or test reports and photos of damage patterns. If necessary, the industry-wide defined properties of the product data templates can be used here. [4]

4.3 Planning and execution support

The information in the model, which is linked to the components, can then be used in the planning phase. For example, for automated analyses, information overviews or also quantity take-offs, bills of quantities or schedules in the execution planning. Simple checks of the model, for example compliance with the required concrete cover, can be automated by means of check rules.

In the future, evaluations based on artificial intelligence and more complex programming are also conceivable here, which use the data to recommend suitable repair procedures and product requirements for the various damaged areas of the specific existing object.

The three-dimensional representation of the model also allows for a better overview and thus, for example, easier conclusions about the causes or effects of damage. Investigation or work orders and the knowledge gained from them can also be clearly spatially assigned.

This information, orders, documents and photos can also be unambiguously reconstructed or adapted and supplemented on the construction site, for example using a tablet, which facilitates execution and prevents misunderstandings. [4]
4.4 Joint work on the model

Another potential advantage of using the BIM methodology is the joint work on the model. Theoretically, all project participants and subcontractors can access the model as a central data source, but if necessary, they can also work in specific, synchronised sub-models and in turn have their information automatically incorporated into the overall model. In the practice of concrete repair, however, this is rarely implemented to this extent today, because often only a few project participants work with BIM, so that analogue information usually has to be added to the model manually in a structured manner. [4]

4.5 Passing on to the client

Finally, the 3D model can then be passed on to the client so that it can offer further added value in the future, for example in building maintenance. This is because all future maintenance measures can be planned on the basis of it and can seamlessly build on the existing data, such as inspection results. However, it is important for this that the model is supplemented with the information of the actual execution of the maintenance measures in order to obtain a as-built model. Here, the specific product information of the product manufacturers also plays an important role.

The transfer of the 3D model to the client also relativises the possible initial additional expenditure for the creation of a 3D model, which, depending on the project, usually pays for itself through the improved project process of the actual concrete repair measure. [4]

5 Product data templates for concrete repair products

Deutsche Bauchemie also structured the relevant characteristics for car parking deck coatings as part of its pilot project. DIN 18532 initially served as the normative basis for this. Of particular importance were the essential characteristics contained in EN 1504. Here, attention was paid to a high degree of conformity, because the lists of characteristics are soon to be extended by characteristics for surface protection systems according to EN 1504-2 and repair mortars according to EN 1504-3 as well as injection products for filling cracks according to EN 1504-5, which are to be compatible with the already existing lists of characteristics.

In the existing list of characteristics for car parking deck coatings, groups of characteristics were formed according to the different components of a car parking deck coating system.

These are, for example:
- Characteristics of primer / sealer
- Characteristics of waterproofing
- Types and areas of application of surface protection systems (OS)
- Some of these characteristics have to be verified according to EN 1504-2:2004.

In the primer/sealer sector, for example, the characteristic "quantity of bonding agent" is defined in [g/m²] on the basis of DIN EN 14188-4:2009-10. This information is relevant for manufacturers and applicators.

<table>
<thead>
<tr>
<th>Quelle</th>
<th>Merkmal englisch</th>
<th>Beschreibung</th>
<th>Aus- prägung</th>
<th>Architekt</th>
<th>Verarbeiter</th>
<th>Hersteller</th>
<th>FM</th>
<th>IFC 2X3 TC1</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIN EN 12617-1: 2003-11</td>
<td>Linear Shrinkage</td>
<td>Bestimmung des linearen Schrumpfens von Polymeren und Oberflächen schutzsystemen (OS) nach DIN EN 12617-1</td>
<td>[%]</td>
<td>ja</td>
<td>ja</td>
<td>nein</td>
<td>#.LinearShrinkage</td>
<td></td>
</tr>
<tr>
<td>DIN EN 12150: 1998-12</td>
<td>Compressive Strength</td>
<td>Verfahren zur Bestimmung der Druckfestigkeit von Mörteln und Betonen für konstruktive und nicht konstruktive Instandsetzungsarbeiten nach EN 1504-1</td>
<td>min fck</td>
<td>ja</td>
<td>ja</td>
<td>ja</td>
<td>#.CompressiveStrength</td>
<td></td>
</tr>
<tr>
<td>EN ISO 5470-1: 2017-04</td>
<td>Abrasion resistance</td>
<td>Widerstand einer Beschichtungssoberfläche gegenüber mechanischer Beanspruchung</td>
<td>ja</td>
<td>ja</td>
<td>ja</td>
<td>#.AbraisionResistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN ISO 7783-1: 2019-02</td>
<td>permeability to carbon dioxide</td>
<td>Dicke der statischen Luftschicht, die unter den gleichen Bedingungen die gleiche Kohlenstoffdioxid-Diffusionsströmichte (Permeabilität) wie die Beschichtung hat. Sie wird in maβer angegeben.</td>
<td>s0</td>
<td>ja</td>
<td>nein</td>
<td>nein</td>
<td>#.PermeabilityToCarbonDioxide</td>
<td></td>
</tr>
<tr>
<td>DIE EN 13529: 2003-12</td>
<td>Exposure Class Chemical Attac</td>
<td>Der Widerstand des Beschichtungssystems gegen starker chemischen Angriff wird anhand der Beanspruchung der Oberfläche des Beschichtungssystems durch eine Prüffläschigkeit beurteilt</td>
<td>Klasse I-III</td>
<td>ja</td>
<td>nein</td>
<td>ja</td>
<td>#.ResistanceToChemicals</td>
<td></td>
</tr>
</tbody>
</table>
From the section "Waterproofing", for example, the arrangement of the waterproofing within the building structure (according to DIN 18532:2017-07) is relevant or the waterproofing construction method, trafficable or non-trafficable. Depending on the arrangement and impact, other waterproofing products must be selected.

The section of "Types and scope of application of surface protection systems (OS)" deals with "Covering for protection against mechanical, thermal and/or environmental exposures" (definition according to DIN 18195-2017-07). The OS systems are assigned to these, such as OS 8 "for rigid coating for trafficable, mechanically heavily loaded surfaces". The associated characteristics of the surface protection system are, for example, the "linear shrinkage" according to EN 12617-2003-11 or the "abrasion resistance, the wear resistance". These are all important parameters for planning. The characteristics of the surface protection system are regulated in EN 1504-2 and have been integrated into the waterproofing standard.

6 Conclusion

BIM offers great potential for more efficient planning, execution and cooperation in concrete repair, especially for larger and more complex measures. As a result, the methodology will certainly also gain importance in this area, as can already be increasingly observed in the construction industry in general. Deutsche Bauchemie would like to support this process with uniform product properties in order to facilitate the interaction of those involved with regard to BIM. To this end, the characteristics already recorded in lists of characteristics will be expanded to include the relevant properties of surface protection systems according to EN 1504-2 and repair mortars according to EN 1504-3 as well as injection products for filling cracks according to EN 1504-5, which will significantly facilitate the use of BIM in the area of concrete repair in terms of information and data.

References

1. Federal Office of Statistics, Germany
3. Interview with M. Bornholdt, S. Illguth, M. Petersen by ‘Bauen im Bestand’, Building Information Modeling (BIM) in der Betoninstandsetzung, 45, 22-28 (2022)