Short Report

1 Introduction and objectives

In the "Step-by-step plan for digital construction and operation " the Federal Ministry of Transport and Digital Infrastructure (BMVI) defines goals and approaches for a holistic and comprehensive application of Building Information Modeling (BIM). Within the framework of this initiative, the legislator demands the use of modern, IT-supported processes and technologies in the planning, construction and operation of public infrastructure buildings from 2020. The development of a BIM-compliant object catalog for transportation and road construction serves as a first basis for a uniform application of the BIM method in infrastructure projects. The implementation took place in the form of a database, in which the most important terms and definitions of the FGSV and IT-Ko regulations were imported as property groups and characteristics. A uniform use of the terms within a set of rules as well as between different sets of rules was investigated. In addition, definitions, descriptions, examples, value ranges, physical quantities and dimensions were assigned to the individual characteristics. The information content in the database is strongly dependent on the level of detail in the respective set of rules. The results of the analysis and the notes on non-harmonized areas of the individual regulations were made available for further committee work and, if necessary, for coordination between different committees. Additional information on representable and non-representable information in digital models was also elaborated. A list of further BIM-relevant regulations and expected innovations in already analyzed regulations can be found in this report. A guide for the systematic analysis of further rules and regulations and for adding them to the database for future data maintenance was written. An implementation example of the database in the form of a three-dimensional data model was generated. In the future, checks regarding the property dependencies can be supplemented by specific queries within a model. Through the exemplary analysis of selected rules and regulations and the development of a suitable database structure, this project can serve as a first step towards a uniform BIM structure for infrastructure construction.

2 Recording of characteristics and characteristic groups

The need for data catalogs with characteristics for specific BIM applications is described in DIN EN ISO 23386, which is currently undergoing commentary. In the introduction of DIN EN ISO 23386 it says:

In the digital built environment, there will be no single data catalog that contains all the definitions needed in all BIM domains. Different groups, possibly in different countries, will create or have already created separate data catalogs tailored to their needs based on legislation and culture. We are facing and will continue to face different separate data catalogs. They may even be on the same platform, but logically they are separate.

For the future of BIM, it is important to ensure that these data catalogs can be interoperable in tools and applications.

- The elements of the data catalogs must be described by the same attributes. If this is agreed upon and implemented by all data catalog providers, it is possible to map features in one data catalog to features in other data catalogs. This can lead to reuse of features and harmonization of features across data catalogs. It is also an important step in enabling BIM applications to use multiple data catalogs in a consistent manner.

- The control of the data catalogs must follow the same rules with respect to the creation and development of the content of the data catalogs.

It is assumed that the data catalogs are independently connected within a coordinated network of data catalogs (again, multiple such networks may exist). Within the network, the data catalogs are related to each other, which is visible, for example, through the use of a particular attribute that maps properties and property sets of different data catalogs to each other. Each data catalog in the network of coordinated data catalogs is independent, i.e. it has its own processes and committees to govern the elaboration and development of the data catalog; meanwhile, all data catalogs follow the same description and governance rules described in this standard.

This document specifies the attributes for defining properties and property sets of a single data catalog, as well as the processes and committees/roles for governance of a single data catalog within a network of coordinated data catalogs. The control processes describe how the single data catalog handles requests and change requests, as well as the extension of requests to other linked data catalogs; information from other linked data catalogs regarding a change is an essential part of this process.”

This document helps to ensure the quality and uniqueness of property descriptions and to avoid the creation of duplicates.

DIN EN ISO 23386:2020 makes the following definitions, which are used within this document:

data catalog: A data catalog is a centralized repository for information about data such as meaning, relationships to other data, origin, use, and format. [Source: ISO 23386:2020, 3.9 data dictionary.]

property: A property is an inherent or acquired characteristic of an object. Characteristics can be used to make a classification. A property may represent the (lowest) level of a classification. A characteristic may belong to more than one group of characteristics. [Source: ISO 23386:2020, 3.17 property]

property set: A property set is a collection of properties that allows features to be organized based on their semantics. There are five categories of possible property sets (cf. Category). Property sets can be organized in tree structures. Each property assigned to a property set is inherited by the subgroup(s) of properties. [Source: ISO 23386:2020, 3.14 group of properties.]

attribute: An attribute is a data element for the machine-readable description of a property or a property set. An attribute describes only a single detail of a property or a property set.

According to ISO 23386:2020, eight pieces of information are kept for machine processing for each attribute of a property or property set. This includes a unique identifier of the attribute, a designation and a description. Furthermore, information about the management rules in interrelated classifications is defined to ensure whether it is mandatory to specify an attribute or not. Furthermore, it is stored whether an attribute must or can be specified by the user or whether it is a system-generated value. [Source: ISO 23386:2020, 3.4 attribute]

category: the different categories of property sets are: Class (as part of a classification according to ISO 12006-2:2015 4.3), Domain (as a summary of attributes related to a field of activity), Reference Document (as a reference to a published technical specification), Composite Attributes (as a collection of dependent attributes), and Alternative Use (for all applications that cannot be represented by the previous ones).

3 Procedures for reviewing the rules and regulations

Selected regulations of the FGSV were first analyzed for characteristics and characteristic groups. These were recorded and described in detail in a prepared Microsoft-Excel® table. This includes definitions, examples, data types, value ranges or units. Due to the complexity of the road construction and traffic system, all terms of the rules and regulations were first recorded and only sorted and assigned in subsequent work steps. For the assignment, relations were also created in tabular form. Relationships are always created by an ID, so that a clear assignment is always possible. Duplications within these selected sets of rules could be eliminated so that a large common structure could develop.

Subsequently, the evaluation tables were checked and adjusted several times, so that they could finally be imported into a database. In the database structure, the hierarchical structures of the individual terms become clear. Each characteristic is assigned to at least one characteristic group according to the given structure. Figure 3 1 shows an excerpt from the database.

	Eigenschaftname	Wert	Datentyp
	Belastungsklasse		
1	: Fahrstreifenbreitenfaktor (f2)	1,1000	xs:double
2	: Achszahlfaktor (fA)	3,3000	xs:double
3	: Belastungsklasse	Bk32	xs:string
4	: Dimensionierungsrelevante Beanspruchung (B)	27,0300	xs:double
5	: DTA	16.500,0000	xs:double
6	: DTV	5.000,0000	xs:double
7	: Fahrstreifenfaktor (f1)	0,5000	xs:double
8	: Lastkollektivquotient (qBM)	0,2300	xs:double
9	: Mittlere jährliche Zunahme des Schwerverkehrs (p)	0,0100	xs:double
10	: Mittlerer jährlicher Zuwachsfaktor des Schwerverkehrs (fz)	1,1590	xs:double
11	: Nutzungszeitraum (N)	30	xs:int
12	: Steigungsfaktor (f3)	1,0200	xs:double

Figure 3-1: extract from the created database

After the final structure of the data collection and import was established, further R1 rules of the FGSV were analyzed and imported into the database. The duplications of all evaluated sets of rules were eliminated in the tables.

After completion of the database, the IT-Ko regulations were compared with the evaluations of the FGSV regulations. Many similarities but also some differences were noticed. The results were recorded in tabular form, so that in the follow-up of the project uniform terms and definitions between the FGSV and the IT-Ko can be found at the appropriate places.

4 Results and evaluation

Altogether 67 FGSV regulations and 10 parts of the instruction road information bank (ASB) of the IT-Ko were analyzed. Ten selected reference rules and regulations of the FGSV were examined in great detail, commented and imported into the database. The other FGSV rules and regulations were checked due to the large amount of data, but no duplications could be filtered out and eliminated. Figure 4 1 shows the data collection of the selected reference rules and thus shows the very large scope of the analyzed terms regarding the characteristics, the groups of characteristics, as well as the relations between the individual terms.

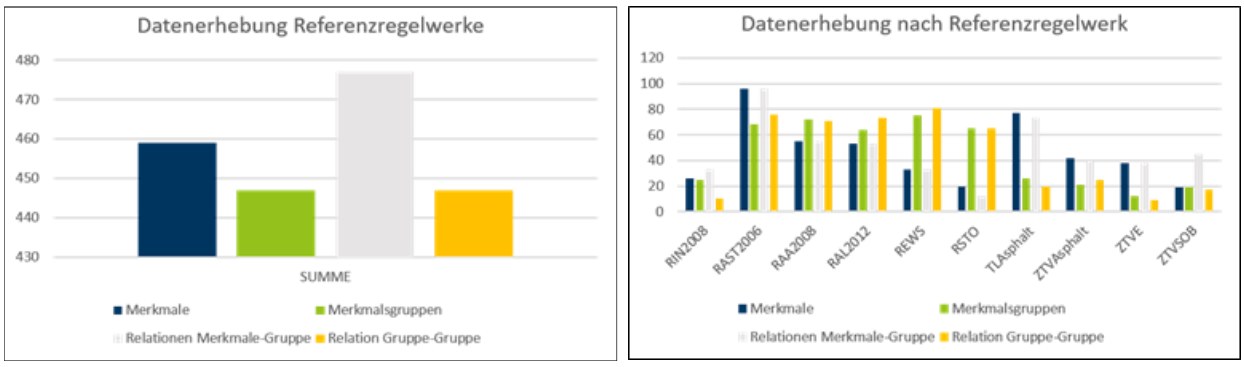

Figure 4-1: Data collection of the reference rules

With regard to the further development and maintenance of the database, a short manual was created, which contains the most important steps for the analysis of new regulations. In addition, a set of rules was worked out, which should be analyzed and implemented in the database after the project. In this context, an indication was also given that essential rules and regulations will soon be revised, so that in these cases the new version should be taken into account if possible. For a few rules and regulations no meaningful implementation into the developed structure could take place, because they are either unfinished rules and regulations or rules and regulations with mainly geometrical specifications and limit values.

The 10 selected parts of the ASB were analyzed and compared with the analyses of the FGSV regulations. These analyses show the currently still unequal positions between the FGSV and the IT-Ko, which should be adjusted in the future.

A possible outlook for the application of the developed structures of the evaluation tables and the database is shown in figure 4 2. From some data of the database an object catalog in form of a model was implemented here.

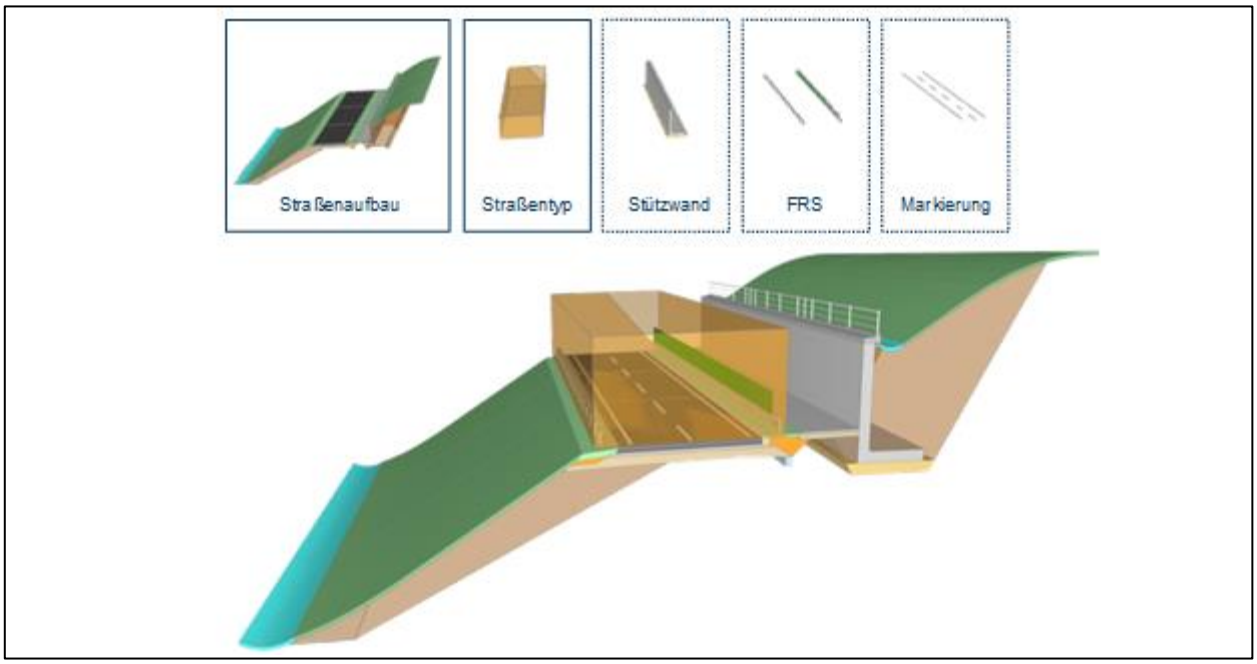

Figure 4-2: possible conversion of the database into a model

5 Summary and outlook

Within the scope of this project, concepts for conformity testing of regulations in connection with Building Information Modeling were presented. For the development of a suitable procedure some reference sets of rules and regulations were selected. The information contained was converted into properties and property groups according to DIN EN ISO 23386. The captured properties and property groups were stored in a graph-based database and can be made available in digital form in the future.

The selected sets of rules for the processing and analysis within the scope of this project were developed by the FGSV and the IT-Ko. In the case of the FGSV rules and regulations, relevant R1 rules and regulations from 2003 onwards were analyzed, and the IT-Ko analyzed several parts of the Road Information Bank (ASB) instruction. A uniform use of the terms within a set of rules as well as between different sets of rules was examined. In addition, definitions, descriptions, examples, value ranges, physical quantities and dimensions were assigned to the individual characteristics. The information content in the database is strongly dependent on the level of detail in the respective set of rules. The results of the analysis and the notes on non-harmonized areas of the individual regulations were made available for further committee work and, if necessary, for coordination between different committees. Additional information on

representable and non-representable information in digital models was also elaborated. A list of further BIM-relevant regulations and expected innovations in already analyzed regulations can be found in this report. A guide for the systematic analysis of further rules and regulations and for adding them to the database for future data maintenance was written. An implementation example of the database in the form of a three-dimensional data model was generated. In the future, checks regarding the property dependencies can be supplemented by specific queries within a model. Through the exemplary analysis of selected rules and regulations and the development of a suitable database structure, this project can serve as a first step towards a uniform BIM structure for infrastructure construction.

According to the BMVI's step-by-step plan " Digital planning and building ", all new infrastructure projects to be planned should be implemented using the BIM methodology. It is therefore particularly important to develop a uniform structure that conforms to existing regulations and to maintain it afterwards. As a further research requirement, the information from the other sets of rules and regulations mentioned in this report should be incorporated into the developed structure. Subsequently, further sets of rules and regulations, such as those of the BMVI, should be included. The aim is to promote and standardize the use of the BIM method in infrastructure construction in Germany by means of uniform structural and object specifications.