Attachment 1 to ToR for Bridge Analytical Module – Bridge Management System Data Model

Skopje, 16.6.2021

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1 INTRODUCTION

In this document, basic information on the Bridge Management System Data model is presented. The purpose of the document is to give additional information on data that will be collected in the bridge inspection process and will be available for BAM SW. the same data model is used also to design a Bridge data collection SW and RAMS upgrade for storing bridge data in central database.

In the data model are presented definition of tables for bridge inventory data, bridge condition data and associated code lists. In this Appendix is described:

- Bridge inventory data and bridge condition data tables
- Schematic presentation of tables with the relations between them
- Definition of XSD schema with XML example needed for data exchange between central BMS IT system and BDC SW

2 DATA TABLES

Data model definition for bridge inventory data and bridge condition data tables were made in Enterprise Architect software. In this Appendix, there is just a description of tables from Enterprise Architect, a complete Enterprise Architect project will be delivered to the selected Consultant at the start of the project.

2.1 Bridge inventory data tables

Table 1: BMS_STRUCTURE - definition of basic structure data

FIELD NAME	FIELD TYPE	DESCRIPTION
Structure_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Unique bridge identification number, composed of 7 characters (Example M001301 - first bridge on the section 0013)*
ID_Structure_Type	Integer	*Type of object selected from code list*
Name	Text 128	*Name of structure*
ID_Crossing_Type	Integer	*Crossing type selected from code list*
Crossing_Name	Text 128	*Name of river, obstacle, …*
Urban_Area	Text 128	*Nearest urban area name*
Road_Number	Text 20	*Road number (A1, P1204,...)*
Total_Length	Float	*Total length of the structure (between first and last expansion joints) - (m)*
Skewness	Float	*Skewness of the structure (°)*
Length_Abutments	Float	*Perpendicular length between abutments - (m)*
Number_Spans	Integer	*Number of spans*
Pavements_Width	Float	*Pavement width, without sidewalks*
Width_Sidewalk_L	Float	*Width of right sidewalk*
Width_Sidewalk_R	Float	*Width of left sidewalk*
Lanes_Num	Integer	*Number of lanes*
Piers_Num	Integer	*Number of piers*
Clearance	Float	*Heigh of free profile (minimum)*

Year_Constr	Integer	*Year of construction*
TLC_Design	Number	*Maximum traffic load, that bridge can be subjected based on design (kN)*
TLC_Assesment	Number	*Maximum traffic load, that bridge can be subjected based on reliability assessment (kN)*
Limits_Other	Text	*Any other limits, e.g. speed limit*
Remark	TEXT (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 2: BMS_STRUCTURE_MATERIAL - definition of structure material

FIELD NAME	FIELD TYPE	DESCRIPTION
Structure_Material_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
ID_Material	Integer	*Type of material selected from code list*
Primary	Integer	*1 - primary, 2 - not primary*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 3: BMS_STRUCTURE_SYSTEM - definition of structure system

FIELD NAME	FIELD TYPE	DESCRIPTION
Structure_System_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
Id_Structure_System	Integer	*Type of Structural System selected from code list*
Primary	Integer	*1 - primary, 2 - not primary*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text	*User who inserted record in BMS database*
User_Kon	Text	*User who set record to history in BMS database*

Table 4: BMS_STRUCTURE_SPANS - definition of structure spans

FIELD NAME	FIELD TYPE	DESCRIPTION
Structure_Span_ID	Number	*Unique record ID*

Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
Span_Number	Integer	*Consecutive span number inside of structure*
Length	Number	*Length of span X (m)*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text	*User who inserted record in BMS database*
User_Kon	Text	*User who set record to history in BMS database*

Table 5: BMS_STRUCTURE_PIERS - definition of structure piers

FIELD NAME	FIELD TYPE	DESCRIPTION
Structure_Piers_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
Piers_Number	Integer	*Consecutive pier number inside of structure*
ID_Substructure_Type	Integer	*Substructure type selected from code list*
Height	Number	*Height of pier X (m)*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text	*User who inserted record in BMS database*
User_Kon	Text	*User who set record to history in BMS database*

Table 6: BMS_STRUCTURE_MAINTENANCE - definition of structure maintenance

FIELD NAME	FIELD TYPE	DESCRIPTION
Structure_Maintenance_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
Year	Integer	*Year of maintenance or reconstruction*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
User_Zac	Text	*User who inserted record in BMS database*

Table 7: BMS_DOCS - table with links to documents, photos, ACAD, archive docs

FIELD NAME	FIELD TYPE	DESCRIPTION
Docs_ID	Number	*Unique record ID*
Table_Name	Text 128	*Name of table with object ID*
Object_ID	Text 128	*Unique ID or code of object inside of table*
ID_Doc_Type	Number	*Document type (document, photo, ..)*
Link	Text 256	*Link to the document, photo, …*
Description	Text 256	*Description of document*
Dat_Zac	Date	*System date of inserted record in BMS database*
User_Zac	Text	*User who inserted record in BMS database*

Table 8: BMS_LOCATION_DATA - definition of structure location (with coordinates and with road section and mileage)

FIELD NAME	FIELD TYPE	DESCRIPTION

Location_Data_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
Road_Number	Text 20	*Road number (A1, P1204,...)*
Road_Section_Number	Text 20	*Road section number (0001, 0607,...)*
Mileage_Start	Number	*Start mileage of object*
Mileage_End	Number	*End mileage of object*
X_Start	Float	*X coordinate of start of object in Macedonian coordinate system*
Y_Start	Float	*Y coordinate of start of object in Macedonian coordinate system*
X_End	Float	*X coordinate of end of object in Macedonian coordinate system*
Y_End	Float	*Y coordinate of end of object in Macedonian coordinate system*
Primary_Location	Integer	*1 -YES, 2-NO*
Geometry_Display	Integer	*1 -YES, 2-NO*
Structure_Geometry	Geometry	*Geometry of object written in BMS database*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text	*User who inserted record in BMS database*
User_Kon	Text	*User who set record to history in BMS database*

2.2 Bridge condition data tables

Table 9: BMS_INSPECTION - definition of all structure inspections

FIELD NAME	FIELD TYPE	DESCRIPTION
Inspection_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
Last_Inspection_Date	Date	*Date of last inspection*
Inspection_Date	Date	*Date of current inspection*
ID_Weather_Type	Integer	*Weather type selected from code list*
Temperature	Float	*Temperature (°C)*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 10: BMS_INSPECTORS - definition of inspectors and their responsibilities

FIELD NAME	FIELD TYPE	DESCRIPTION
Inspector_ID	Number	*Unique record ID*
Inspection_ID	Number	*Relation to record from table BMS_INSPECTION*
ID_Inspector	Integer	*Inspector selected from code list*

Responsibility	Integer	*1 - main inspector; 2 - support inspector*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 11: BMS_STRUCTURE_ELEMENTS - definition of structure elements

FIELD NAME	FIELD TYPE	DESCRIPTION
Element_ID	Number	*Unique record ID*
Structure_Code	Text 20	*Relation to record from table BMS_STRUCTURE*
ID_Group_Elements	Integer	*Automatically selected from group element code list on the base of selected element*
ID_Location	Integer	*Location selected from code list*
Location_number	Integer	*Counter that defines the location for spans, piers, abutment, approach*
ID_Element	Integer	*Element selected from code list*
ID_Material	Integer	*Material selected from code list*
Remark	Tex (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 12: BMS_CONDITION_ELEMENT - definition of condition of structure elements

FIELD NAME	FIELD TYPE	DESCRIPTION
Condition_Element_ID	Number	*Unique record ID*
Element_ID	Number	*Relation to record from table BMS_STRUCTURE_ELEMENTS*
Inspection_ID	Number	*Relation to record from table BMS_INSPECTION*
ID_ECI	Integer	*Condition index for element regarding damage catalogue*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 13: BMS_CONDITION_STRUCTURE - definition of condition of structure

FIELD NAME	FIELD TYPE	DESCRIPTION
Condition_Structure_ID	Number	*Unique record ID*
Structure_Code	Text	*Relation to record from table BMS_STRUCTURE*
Inspection_ID	Number	*Relation to record from table BMS_INSPECTION*
ID_BCI	Integer	*Condition index for entire structure selected from code list*

Condition	Text (blob)	*Description of the current condition state*
Changes	Text (blob)	*Description of the changes from last inspection*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 14: BMS_CONDITION_STRUCTURE_MEASURES - definition of structure measures

FIELD NAME	FIELD TYPE	DESCRIPTION
Condition_Structure_Measure_ID	Number	*Unique record ID*
Location	Integer	*1 - structure, 2 - element*
Condition_Structure_Location_ID	Number	*Reference to table BMS_CONDITION_STRUCTURE*
ID_Recc_M	Integer	*Recommended measures elected from code list*
Remark	Text (blob)	*Remarks, comments, …*
Dat_Zac	Date	*System date of inserted record in BMS database*
Dat_Kon	Date	*System date of setting record in history in BMS database*
User_Zac	Text 128	*User who inserted record in BMS database*
User_Kon	Text 128	*User who set record to history in BMS database*

Table 15: BMS_DAMAGE_RECORDING - definition of damages on structure elements

FIELD NAME	FIELD TYPE	DESCRIPTION
Damage_Recording_ID	Number	*Unique record ID*
Condition_Element_ID	Number	*Reference to table BMS_CONDITION_ELEMENT*
ID_Damage_type	Integer	*Type of damages from code list*
Attribute1	Float	*Damage value on the base of code list depending on element, material and damage type*
Attribute2	Float	*Damage value on the base of code list depending on element, material and damage type*
Attribute3	Float	*Damage value on the base of code list depending on element, material and damage type*
Attribute4	Float	*Damage value on the base of code list depending on element, material and damage type*
Attribute5	Text	*Damage value on the base of code list depending on element, material and damage type*
Attribute6	Text	*Damage value on the base of code list depending on element, material and damage type*

Table 16: BMS_DAMAGE_RECORDING_ATTRIBUTES - definition of attributes for damage recording on structure elements

ID Element	ID Material	ID Damage Type	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Attribute 5	Attribute 6
1-	1	*1*	*Max*	*/*	*/*	*/*	*Type*	*Comment*

11,14,22			*width [mm]*					
1-11,14,22	1	*2*	reduced cross-section area *[%]*	/	/	/	*Scope*	*Comment*
1-11,14,22	1	*3*	*Area [m^2]*	/	/	/	/	*Comment*
1-11,14,22	1	*4*	/	/	/	/	/	*Comment*
…	…	…	…	…	…	…	…	…

2.3 Code list tables

Table 17: LIST_STRUCTURE_TYPE

ID_Structure_Type	Abbreviation	Structure_Type
1	M	Bridge
2	N	Overpass
3	P	Underpass
4	V	Viaduct
9	O	Other

Table 18: LIST_CROSSING_TYPE

ID_Crossing_Type	Abbreviation	Crossing_Type
1	V	Water
2	P	Road
3	Z	Railway
4	N	Urban areas
9	O	Others

Table 19: LIST_MATERIAL

ID_Material	Material
1	Concrete
2	Steel
3	Timber
4	Masonry
99	Other

Table 20: LIST_STRUCTURE_SYSTEM

ID_Structure_System	Structure_System
1	Beams/girders
2	Integral/frame type
3	Slab
4	Trusses

5	Vault
6	Arc

Table 21: LIST_SUBSTRUCTURE_TYPE

ID_Substructure_Type	Type
1	Abutment
2	Pier

Table 22: LIST_DOC_TYPE

ID_Doc_Type	Type
1	Document
2	Photo
3	ACAD
4	Digital Archive file
9	Other

Table 23: LIST_WEATHER

ID_Weather_Type	Weather_Type
1	Sunny
2	Cloudy
…	…

Table 24: LIST_INSPECTOR

ID_Inspector	Inspector_Name
1	Inspector 1
2	Inspector 2
3	Inspector 3
…	…

Table 25: LIST_GROUP_ELEMENTS

ID_Group_Elements	Group_Elements
1	Support-structure
2	Superstructure
3	Roadway
4	Equipment

Table 26: LIST_LOCATION

ID_Location	Location
1	General
2	Approach
3	Abutment

4	Pier
5	Span

Table 27: LIST_ELEMENTS

ID_Element	Element	ID_Group_Elements
1	Foundation	1
2	Abutments	1
3	Pier/Intermediate support	1
4	Wing wall and retaining-supporting wall	1
5	Slab	2
6	Main girder/beam	2
7	Crossbeam	2
8	Box girder	2
9	Arch and vault	2
10	Truss	2
11	Sidewalk structure	2
12	Approach to the bridge	3
13	Pavement and waterproofing	3
14	Prefabricated front panel+sidewalk+kerbs+joints	3
15	Steel bearing	4
16	Concrete Bearing	4
17	Timber bearing	4
18	Neoprene bearing	4
19	Teflon bearing	4
20	Lead bearing	4
21	Expansion joint	4
22	Railing and crash barriers	4
23	Lighting pole and traffic sign	4
24	Pipeline	4
25	Drainage system	4

Table 28: LIST_ECI

ID_ECI	ECI
1	1
2	2
3	3
4	4
5	Not inspected

Table 29: LIST_BCI

ID_BCI	BCI
1	1
2	2
3	3
4	4
5	5
6	Not inspected

Table 30: LIST_RECC_M

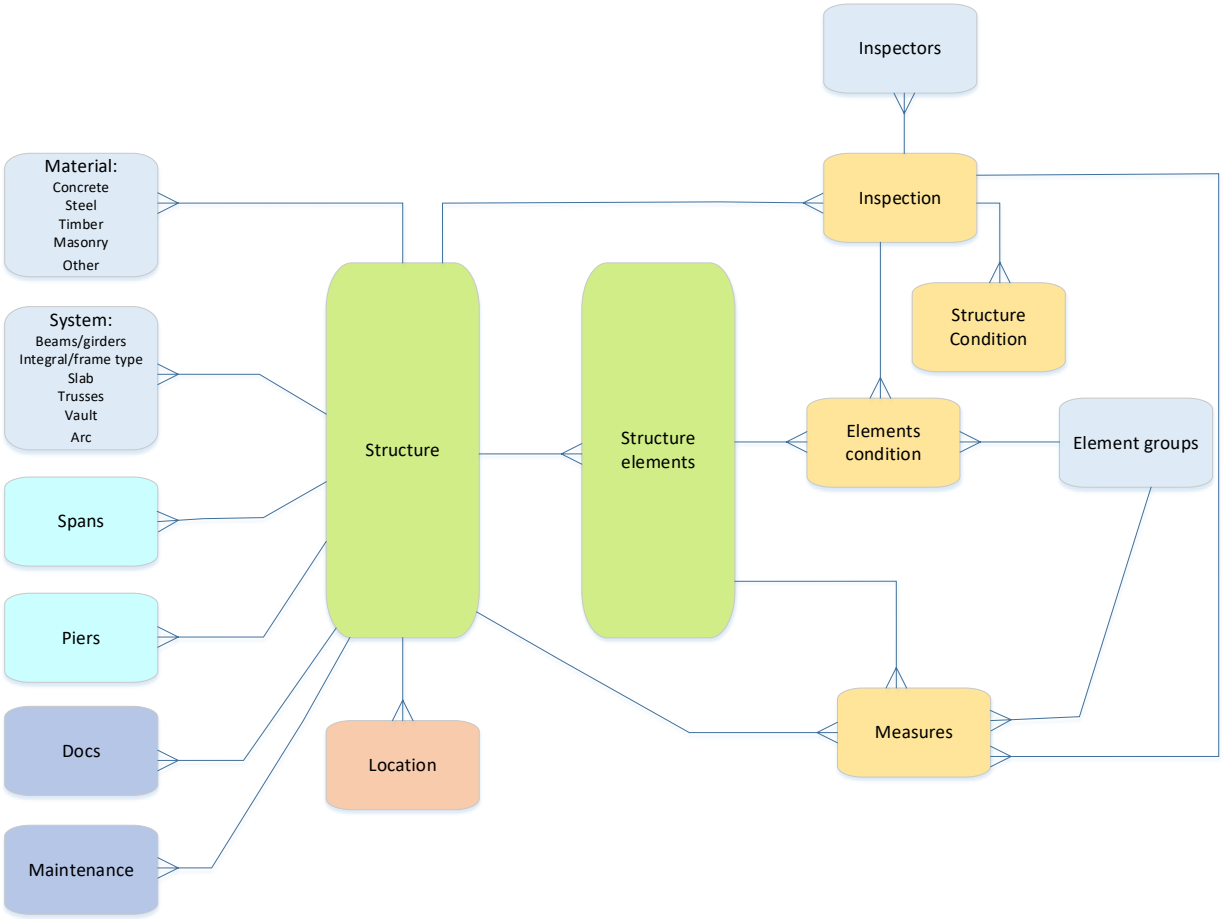
ID_Recc_M	Location	Recc_M
1	1	Rehabilitation
2	1	Replacement
3	1	In-detail inspection
4	1	Regular maintenance
5	3	Local maintenance
6	3	Repair
7	3	Repair with strengthening
8	3	Replacement/change
9	3	In-detail inspection

Table 31: LIST_DAMAGE_TYPE

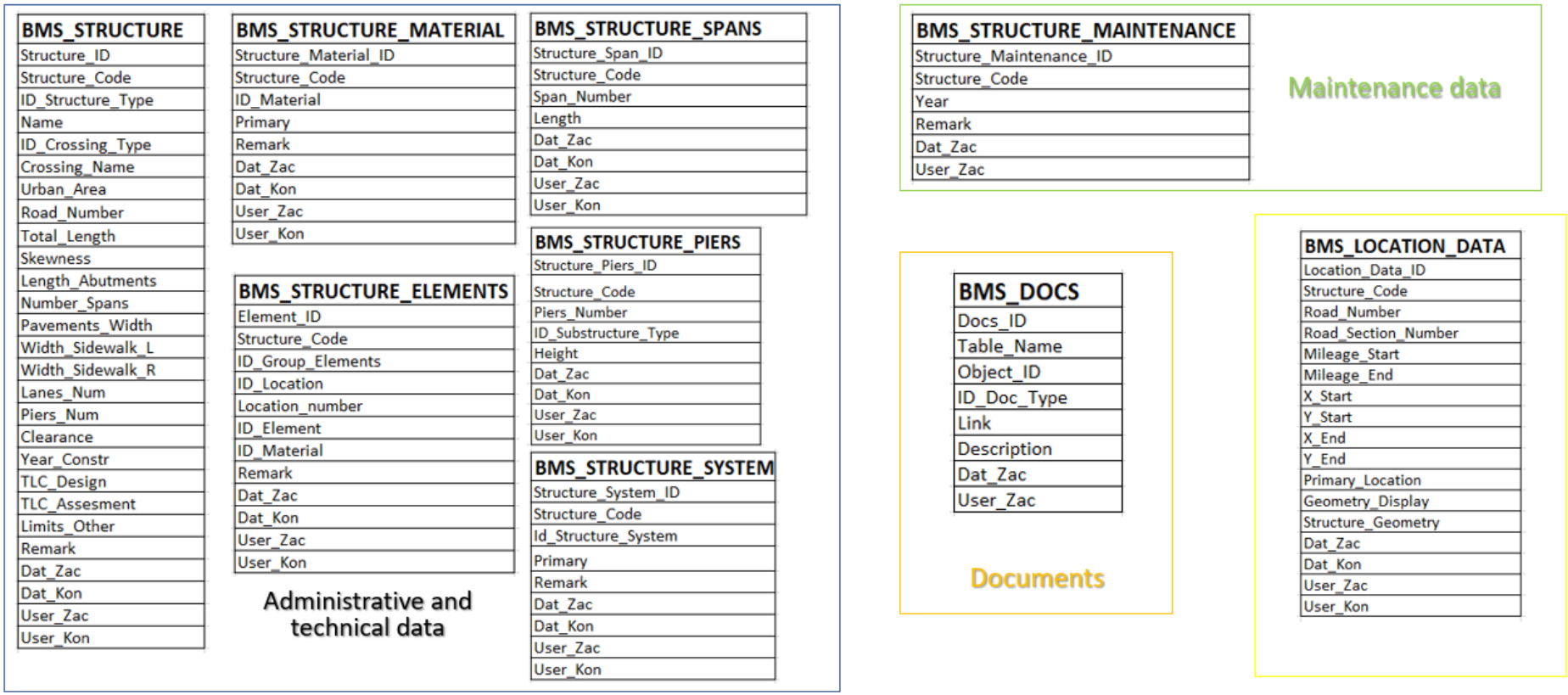
ID_Damage_Type	Damage type
1	Crack
2	Corrosion
3	Delamination
4	Leackeage
…	…

3 SCHEMATIC PRESENTATION OF DATA TABLES

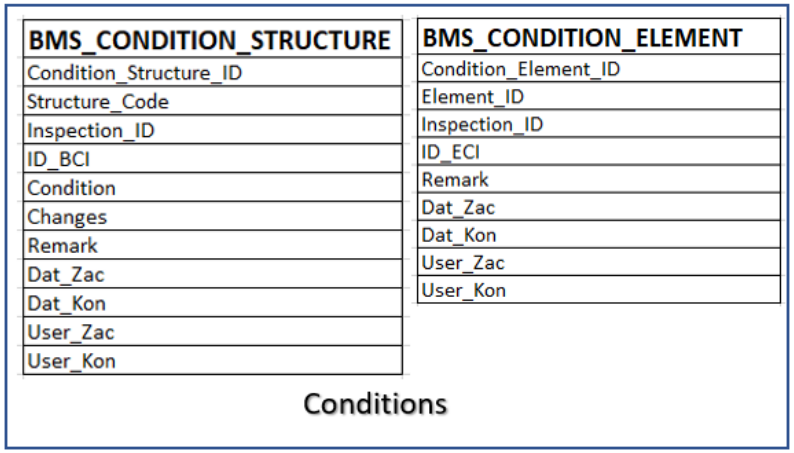
Schematic presentation of main tables and basic relationships between structure data, structure elements and inspections.

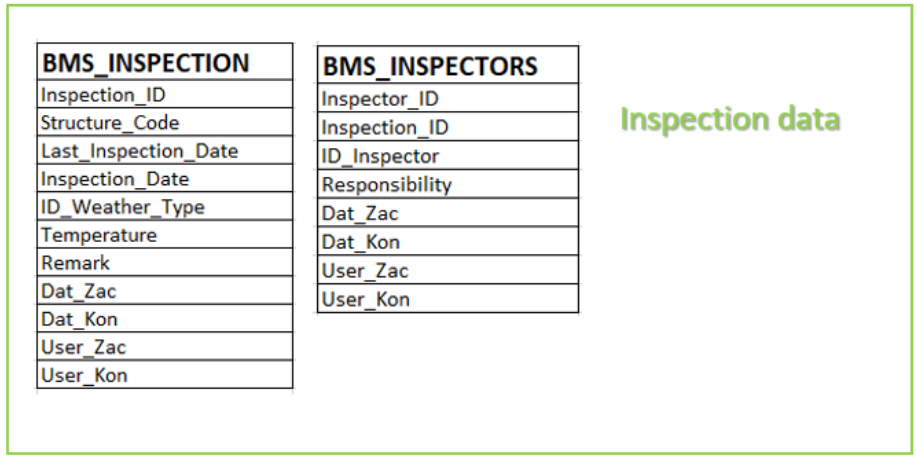


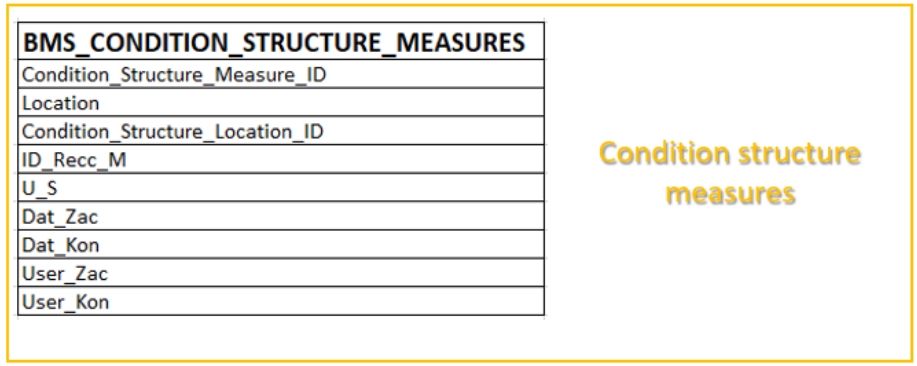
Bridge inventory database model – thematically grouped tables (part 1).



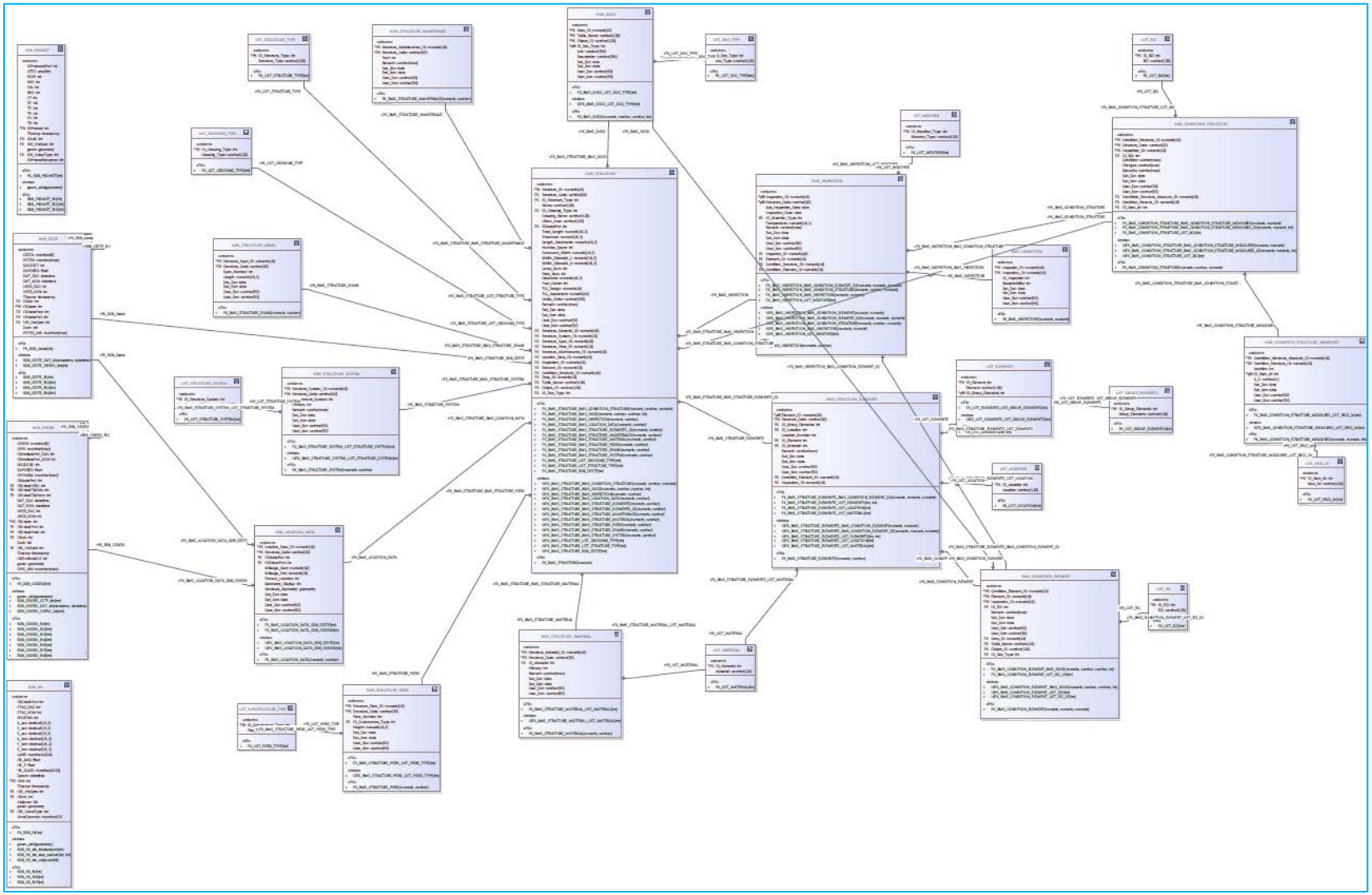
Bridge condition database model – thematically grouped tables (part 2).







Relations between tables presented in Enterprise Architect.



4 XSD SCHEMA WITH XML

XML specification defines exchange data format for bridge data. The XML exchange format will be primary use for delivering bridge inventory and condition data collected in bridge survey but also to distribute existing bridge data from BMS central IT system to BDC SW used for field inspections.

XSD Schema set the structure of the exchanged data: elements, attribute of elements and also values for code lists. It is created with Common Information Model (CIM) standards. CIM Schema delivers semantically detailed, object-oriented model descriptions for all managed elements. It serves for validation of XML file when it is prepared for every structure separately.

Complete data model for bridge inventory data and bridge condition data, and also class model which defines XSD schema, will be delivered to the selected Consultant at the beginning of the project.

4.1 XSD schema

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:sawsdl="http://www.w3.org/ns/sawsdl" xmlns:m="http://iec.ch/TC57/xml_bms_cim#"
targetNamespace="http://iec.ch/TC57/xml_bms_cim#" elementFormDefault="qualified" attributeFormDefault="unqualified">
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	<xs:complexType name="xml_bms_cim">
		<xs:sequence>
			<xs:element name="BMS_CONDITION_STRUCTURE" type="m:BMS_CONDITION_STRUCTURE" minOccurs="1" maxOccurs="1"/>
			<xs:element name="BMS_INSPECTION" type="m:BMS_INSPECTION" minOccurs="1" maxOccurs="1"/>
			<xs:element name="BMS_INSPECTORS" type="m:BMS_INSPECTORS" minOccurs="1" maxOccurs="unbounded"/>
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			<xs:element name="BMS_STRUCTURE_PIERS" type="m:BMS_STRUCTURE_PIERS" minOccurs="1" maxOccurs="unbounded"/>
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			<xs:element name="ID_BCI" minOccurs="1" maxOccurs="1" type="m:ID_BCI" sawsdl:modelReference="#BMS_CONDITION_STRUCTURE.ID_BCI"/>
		</xs:sequence>
```

```
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                        <xs:element name="Last_Inspection_Date" minOccurs="1" maxOccurs="1" type="xs:date"
sawsdl:modelReference="#BMS_INSPECTION.Last_Inspection_Date"/>
                        <xs:element name="Remark" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_INSPECTION.Remark"/>
                        <xs:element name="Temperature" minOccurs="1" maxOccurs="1" type="xs:double"
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                        <xs:element name="Road_Section_Number" minOccurs="1" maxOccurs="1" type="xs:string"
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                        <xs:element name="Y_Start" minOccurs="1" maxOccurs="1" type="xs:double" sawsdl:modelReference="#BMS_LOCATION_DATA.Y_Start"/>
                        <xs:element name="Geometry_Display" minOccurs="1" maxOccurs="1" type="m:Geometry_Display"
sawsdl:modelReference="#BMS_LOCATION_DATA.Geometry_Display"/>
                        <xs:element name="Primary_Location" minOccurs="1" maxOccurs="1" type="m:Primary_Location"
sawsdl:modelReference="#BMS_LOCATION_DATA.Primary_Location"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE" sawsdl:modelReference="#BMS_STRUCTURE">
                <xs:sequence>
                        <xs:element name="Clearance" minOccurs="1" maxOccurs="1" type="xs:float" sawsdl:modelReference="#BMS_STRUCTURE.Clearance"/>
```

```
                        <xs:element name="Crossing_Name" minOccurs="1" maxOccurs="1" type="xs:string"
sawsdl:modelReference="#BMS_STRUCTURE.Crossing_Name"/>
                        <xs:element name="Lanes_Num" minOccurs="1" maxOccurs="1" type="xs:integer" sawsdl:modelReference="#BMS_STRUCTURE.Lanes_Num"/>
                        <xs:element name="Length_Abutments" minOccurs="1" maxOccurs="1" type="xs:float"
sawsdl:modelReference="#BMS_STRUCTURE.Length_Abutments"/>
                        <xs:element name="Limits_Other" minOccurs="1" maxOccurs="1" type="xs:string"
sawsdl:modelReference="#BMS_STRUCTURE.Limits_Other"/>
                        <xs:element name="Name" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE.Name"/>
                        <xs:element name="Number_Spans" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE.Number_Spans"/>
                        <xs:element name="Pavements_Width" minOccurs="1" maxOccurs="1" type="xs:float"
sawsdl:modelReference="#BMS_STRUCTURE.Pavements_Width"/>
                        <xs:element name="Piers_Num" minOccurs="1" maxOccurs="1" type="xs:integer" sawsdl:modelReference="#BMS_STRUCTURE.Piers_Num"/>
                        <xs:element name="Remark" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE.Remark"/>
                        <xs:element name="Road_Number" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE.Road_Number"/>
                        <xs:element name="Skewness" minOccurs="1" maxOccurs="1" type="xs:float" sawsdl:modelReference="#BMS_STRUCTURE.Skewness"/>
                        <xs:element name="Structure_Code" minOccurs="1" maxOccurs="1" type="xs:string"
sawsdl:modelReference="#BMS_STRUCTURE.Structure_Code"/>
                        <xs:element name="TLC_Assesment" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE.TLC_Assesment"/>
                        <xs:element name="TLC_Design" minOccurs="1" maxOccurs="1" type="xs:integer" sawsdl:modelReference="#BMS_STRUCTURE.TLC_Design"/>
                        <xs:element name="Total_Length" minOccurs="1" maxOccurs="1" type="xs:float"
sawsdl:modelReference="#BMS_STRUCTURE.Total_Length"/>
                        <xs:element name="Urban_Area" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE.Urban_Area"/>
                        <xs:element name="Width_Sidewalk_L" minOccurs="1" maxOccurs="1" type="xs:float"
sawsdl:modelReference="#BMS_STRUCTURE.Width_Sidewalk_L"/>
                        <xs:element name="Width_Sidewalk_R" minOccurs="1" maxOccurs="1" type="xs:float"
sawsdl:modelReference="#BMS_STRUCTURE.Width_Sidewalk_R"/>
                        <xs:element name="Year_Constr" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE.Year_Constr"/>
                        <xs:element name="ID_Crossing_Type" minOccurs="1" maxOccurs="1" type="m:ID_Crossing_Type"
sawsdl:modelReference="#BMS_STRUCTURE.ID_Crossing_Type"/>
                        <xs:element name="ID_Structure_Type" minOccurs="1" maxOccurs="1" type="m:ID_Structure_Type"
sawsdl:modelReference="#BMS_STRUCTURE.ID_Structure_Type"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE_ELEMENTS" sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS">
                <xs:sequence>
                        <xs:element name="Location_Number" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS.Location_Number"/>
                        <xs:element name="Remark" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS.Remark"/>
                        <xs:element name="ID_ECI" minOccurs="1" maxOccurs="1" type="m:ID_ECI" sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS.ID_ECI"/>
                        <xs:element name="ID_Element" minOccurs="1" maxOccurs="1" type="m:ID_Element"
sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS.ID_Element"/>
                        <xs:element name="ID_Location" minOccurs="1" maxOccurs="1" type="m:ID_Location"
sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS.ID_Location"/>
```

```
                        <xs:element name="ID_Material" minOccurs="1" maxOccurs="1" type="m:ID_Material"
sawsdl:modelReference="#BMS_STRUCTURE_ELEMENTS.ID_Material"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE_MAINTENANCE" sawsdl:modelReference="#BMS_STRUCTURE_MAINTENANCE">
                <xs:sequence>
                        <xs:element name="Remark" minOccurs="1" maxOccurs="1" type="xs:string"
sawsdl:modelReference="#BMS_STRUCTURE_MAINTENANCE.Remark"/>
                        <xs:element name="Year" minOccurs="1" maxOccurs="1" type="xs:integer" sawsdl:modelReference="#BMS_STRUCTURE_MAINTENANCE.Year"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE_MATERIAL" sawsdl:modelReference="#BMS_STRUCTURE_MATERIAL">
                <xs:sequence>
                        <xs:element name="Primary" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE_MATERIAL.Primary"/>
                        <xs:element name="Remark" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE_MATERIAL.Remark"/>
                        <xs:element name="ID_Material" minOccurs="1" maxOccurs="1" type="m:ID_Material"
sawsdl:modelReference="#BMS_STRUCTURE_MATERIAL.ID_Material"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE_PIERS" sawsdl:modelReference="#BMS_STRUCTURE_PIERS">
                <xs:sequence>
                        <xs:element name="Height" minOccurs="1" maxOccurs="1" type="xs:float" sawsdl:modelReference="#BMS_STRUCTURE_PIERS.Height"/>
                        <xs:element name="Piers_Number" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE_PIERS.Piers_Number"/>
                        <xs:element name="ID_Substructure_Type" minOccurs="1" maxOccurs="1" type="m:ID_Substructure_Type"
sawsdl:modelReference="#BMS_STRUCTURE_PIERS.ID_Substructure_Type"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE_SPANS" sawsdl:modelReference="#BMS_STRUCTURE_SPANS">
                <xs:sequence>
                        <xs:element name="Length" minOccurs="1" maxOccurs="1" type="xs:float" sawsdl:modelReference="#BMS_STRUCTURE_SPANS.Length"/>
                        <xs:element name="Span_Number" minOccurs="1" maxOccurs="1" type="xs:integer"
sawsdl:modelReference="#BMS_STRUCTURE_SPANS.Span_Number"/>
                </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BMS_STRUCTURE_SYSTEM" sawsdl:modelReference="#BMS_STRUCTURE_SYSTEM">
                <xs:sequence>
                        <xs:element name="Primary" minOccurs="1" maxOccurs="1" type="xs:integer" sawsdl:modelReference="#BMS_STRUCTURE_SYSTEM.Primary"/>
                        <xs:element name="Remark" minOccurs="1" maxOccurs="1" type="xs:string" sawsdl:modelReference="#BMS_STRUCTURE_SYSTEM.Remark"/>
                        <xs:element name="ID_Structure_System" minOccurs="1" maxOccurs="1" type="m:ID_Structure_System"
sawsdl:modelReference="#BMS_STRUCTURE_SYSTEM.ID_Structure_System"/>
                </xs:sequence>
        </xs:complexType>
        <xs:simpleType name="Geometry_Display" sawsdl:modelReference="#Geometry_Display">
                <xs:restriction base="xs:string">
```

```
                <xs:enumeration value="1" sawsdl:modelReference="#Geometry_Display.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#Geometry_Display.2"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_BCI" sawsdl:modelReference="#ID_BCI">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_BCI.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_BCI.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_BCI.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_BCI.4"/>
                <xs:enumeration value="5" sawsdl:modelReference="#ID_BCI.5"/>
                <xs:enumeration value="6" sawsdl:modelReference="#ID_BCI.6"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Crossing_Type" sawsdl:modelReference="#ID_Crossing_Type">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Crossing_Type.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Crossing_Type.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Crossing_Type.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Crossing_Type.4"/>
                <xs:enumeration value="9" sawsdl:modelReference="#ID_Crossing_Type.9"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_ECI" sawsdl:modelReference="#ID_ECI">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_ECI.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_ECI.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_ECI.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_ECI.4"/>
                <xs:enumeration value="5" sawsdl:modelReference="#ID_ECI.5"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Element" sawsdl:modelReference="#ID_Element">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Element.1"/>
                <xs:enumeration value="10" sawsdl:modelReference="#ID_Element.10"/>
                <xs:enumeration value="11" sawsdl:modelReference="#ID_Element.11"/>
                <xs:enumeration value="12" sawsdl:modelReference="#ID_Element.12"/>
                <xs:enumeration value="13" sawsdl:modelReference="#ID_Element.13"/>
                <xs:enumeration value="14" sawsdl:modelReference="#ID_Element.14"/>
                <xs:enumeration value="15" sawsdl:modelReference="#ID_Element.15"/>
                <xs:enumeration value="16" sawsdl:modelReference="#ID_Element.16"/>
                <xs:enumeration value="17" sawsdl:modelReference="#ID_Element.17"/>
                <xs:enumeration value="18" sawsdl:modelReference="#ID_Element.18"/>
                <xs:enumeration value="19" sawsdl:modelReference="#ID_Element.19"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Element.2"/>
```

```
                <xs:enumeration value="20" sawsdl:modelReference="#ID_Element.20"/>
                <xs:enumeration value="21" sawsdl:modelReference="#ID_Element.21"/>
                <xs:enumeration value="22" sawsdl:modelReference="#ID_Element.22"/>
                <xs:enumeration value="23" sawsdl:modelReference="#ID_Element.23"/>
                <xs:enumeration value="24" sawsdl:modelReference="#ID_Element.24"/>
                <xs:enumeration value="25" sawsdl:modelReference="#ID_Element.25"/>
                <xs:enumeration value="26" sawsdl:modelReference="#ID_Element.26"/>
                <xs:enumeration value="27" sawsdl:modelReference="#ID_Element.27"/>
                <xs:enumeration value="28" sawsdl:modelReference="#ID_Element.28"/>
                <xs:enumeration value="29" sawsdl:modelReference="#ID_Element.29"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Element.3"/>
                <xs:enumeration value="30" sawsdl:modelReference="#ID_Element.30"/>
                <xs:enumeration value="31" sawsdl:modelReference="#ID_Element.31"/>
                <xs:enumeration value="32" sawsdl:modelReference="#ID_Element.32"/>
                <xs:enumeration value="33" sawsdl:modelReference="#ID_Element.33"/>
                <xs:enumeration value="34" sawsdl:modelReference="#ID_Element.34"/>
                <xs:enumeration value="35" sawsdl:modelReference="#ID_Element.35"/>
                <xs:enumeration value="36" sawsdl:modelReference="#ID_Element.36"/>
                <xs:enumeration value="37" sawsdl:modelReference="#ID_Element.37"/>
                <xs:enumeration value="38" sawsdl:modelReference="#ID_Element.38"/>
                <xs:enumeration value="39" sawsdl:modelReference="#ID_Element.39"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Element.4"/>
                <xs:enumeration value="40" sawsdl:modelReference="#ID_Element.40"/>
                <xs:enumeration value="41" sawsdl:modelReference="#ID_Element.41"/>
                <xs:enumeration value="42" sawsdl:modelReference="#ID_Element.42"/>
                <xs:enumeration value="43" sawsdl:modelReference="#ID_Element.43"/>
                <xs:enumeration value="44" sawsdl:modelReference="#ID_Element.44"/>
                <xs:enumeration value="45" sawsdl:modelReference="#ID_Element.45"/>
                <xs:enumeration value="46" sawsdl:modelReference="#ID_Element.46"/>
                <xs:enumeration value="47" sawsdl:modelReference="#ID_Element.47"/>
                <xs:enumeration value="48" sawsdl:modelReference="#ID_Element.48"/>
                <xs:enumeration value="49" sawsdl:modelReference="#ID_Element.49"/>
                <xs:enumeration value="5" sawsdl:modelReference="#ID_Element.5"/>
                <xs:enumeration value="50" sawsdl:modelReference="#ID_Element.50"/>
                <xs:enumeration value="51" sawsdl:modelReference="#ID_Element.51"/>
                <xs:enumeration value="52" sawsdl:modelReference="#ID_Element.52"/>
                <xs:enumeration value="53" sawsdl:modelReference="#ID_Element.53"/>
                <xs:enumeration value="54" sawsdl:modelReference="#ID_Element.54"/>
                <xs:enumeration value="55" sawsdl:modelReference="#ID_Element.55"/>
                <xs:enumeration value="6" sawsdl:modelReference="#ID_Element.6"/>
                <xs:enumeration value="7" sawsdl:modelReference="#ID_Element.7"/>
                <xs:enumeration value="8" sawsdl:modelReference="#ID_Element.8"/>
                <xs:enumeration value="9" sawsdl:modelReference="#ID_Element.9"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Inspector" sawsdl:modelReference="#ID_Inspector">
```

```
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Inspector.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Inspector.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Inspector.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Inspector.4"/>
                <xs:enumeration value="5" sawsdl:modelReference="#ID_Inspector.5"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Location" sawsdl:modelReference="#ID_Location">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Location.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Location.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Location.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Location.4"/>
                <xs:enumeration value="5" sawsdl:modelReference="#ID_Location.5"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Material" sawsdl:modelReference="#ID_Material">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Material.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Material.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Material.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Material.4"/>
                <xs:enumeration value="99" sawsdl:modelReference="#ID_Material.99"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Structure_System" sawsdl:modelReference="#ID_Structure_System">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Structure_System.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Structure_System.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Structure_System.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Structure_System.4"/>
                <xs:enumeration value="5" sawsdl:modelReference="#ID_Structure_System.5"/>
                <xs:enumeration value="6" sawsdl:modelReference="#ID_Structure_System.6"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Structure_Type" sawsdl:modelReference="#ID_Structure_Type">
        <xs:restriction base="xs:string">
                <xs:enumeration value="1" sawsdl:modelReference="#ID_Structure_Type.1"/>
                <xs:enumeration value="2" sawsdl:modelReference="#ID_Structure_Type.2"/>
                <xs:enumeration value="3" sawsdl:modelReference="#ID_Structure_Type.3"/>
                <xs:enumeration value="4" sawsdl:modelReference="#ID_Structure_Type.4"/>
                <xs:enumeration value="9" sawsdl:modelReference="#ID_Structure_Type.9"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="ID_Substructure_Type" sawsdl:modelReference="#ID_Substructure_Type">
```

```
                <xs:restriction base="xs:string">
                        <xs:enumeration value="1" sawsdl:modelReference="#ID_Substructure_Type.1"/>
                        <xs:enumeration value="2" sawsdl:modelReference="#ID_Substructure_Type.2"/>
                </xs:restriction>
        </xs:simpleType>
        <xs:simpleType name="ID_Weather_Type" sawsdl:modelReference="#ID_Weather_Type">
                <xs:restriction base="xs:string">
                        <xs:enumeration value="1" sawsdl:modelReference="#ID_Weather_Type.1"/>
                        <xs:enumeration value="2" sawsdl:modelReference="#ID_Weather_Type.2"/>
                        <xs:enumeration value="3" sawsdl:modelReference="#ID_Weather_Type.3"/>
                        <xs:enumeration value="4" sawsdl:modelReference="#ID_Weather_Type.4"/>
                        <xs:enumeration value="5" sawsdl:modelReference="#ID_Weather_Type.5"/>
                </xs:restriction>
        </xs:simpleType>
        <xs:simpleType name="Primary_Location" sawsdl:modelReference="#Primary_Location">
                <xs:restriction base="xs:string">
                        <xs:enumeration value="1" sawsdl:modelReference="#Primary_Location.1"/>
                        <xs:enumeration value="2" sawsdl:modelReference="#Primary_Location.2"/>
                </xs:restriction>
        </xs:simpleType>
        <xs:simpleType name="Responsibility" sawsdl:modelReference="#Responsibility">
                <xs:restriction base="xs:string">
                        <xs:enumeration value="1" sawsdl:modelReference="#Responsibility.1"/>
                        <xs:enumeration value="2" sawsdl:modelReference="#Responsibility.2"/>
                </xs:restriction>
        </xs:simpleType>
</xs:schema>
```

4.2 XML example

```
<?xml version="1.0" encoding="utf-8"?>
<xml_bms_cim xmlns="http://iec.ch/TC57/xml_bms_cim#" xmlns:sawsdl="http://www.w3.org/ns/sawsdl" xsi:schemaLocation="http://iec.ch/TC57/xml_bms_cim#
schema.xsd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <BMS_CONDITION_STRUCTURE>
    <Changes>There are no changes since last inspection.</Changes>
    <Condition>Bridge is in perfect condition.</Condition>
    <Remark>New inspection in three years.</Remark>
    <ID_BCI>1</ID_BCI>
  </BMS_CONDITION_STRUCTURE>
  <BMS_INSPECTION>
    <Inspection_Date>2021-03-23</Inspection_Date>
    <Last_Inspection_Date>2019-08-13</Last_Inspection_Date>
    <Remark>Perfect day for inspection :).</Remark>
    <Temperature>18.4</Temperature>
    <ID_Weather_Type>1</ID_Weather_Type>
  </BMS_INSPECTION>
```

```
<BMS_INSPECTORS>
  <ID_Inspector>2</ID_Inspector>
  <Responsibility>1</Responsibility>
</BMS_INSPECTORS>
<BMS_INSPECTORS>
  <ID_Inspector>5</ID_Inspector>
  <Responsibility>2</Responsibility>
</BMS_INSPECTORS>
<BMS_INSPECTORS>
  <ID_Inspector>1</ID_Inspector>
  <Responsibility>2</Responsibility>
</BMS_INSPECTORS>
<BMS_LOCATION_DATA>
  <Road_Number>P2233</Road_Number>
  <Road_Section_Number>1527</Road_Section_Number>
  <Mileage_End>26529</Mileage_End>
  <Mileage_Start>26470</Mileage_Start>
  <X_End>497625.12</X_End>
  <X_Start>497608.80</X_Start>
  <Y_End>4649044.76</Y_End>
  <Y_Start>4649101.80</Y_Start>
  <Geometry_Display>1</Geometry_Display>
  <Primary_Location>2</Primary_Location>
</BMS_LOCATION_DATA>
<BMS_STRUCTURE>
  <Clearance>8.42</Clearance>
  <Crossing_Name>Highway A2</Crossing_Name>
  <Road_Number>A2</Road_Number>
  <Lanes_Num>2</Lanes_Num>
  <Length_Abutments>30.52</Length_Abutments>
  <Limits_Other>Speed limit 50 km/h.</Limits_Other>
  <Name>Bridge name.</Name>
  <Number_Spans>3</Number_Spans>
  <Pavements_Width>6.5</Pavements_Width>
  <Piers_Num>2</Piers_Num>
  <Remark>Remark.</Remark>
  <Skewness>80</Skewness>
  <Structure_Code>0060_6</Structure_Code>
  <TLC_Assesment>45</TLC_Assesment>
  <TLC_Design>40</TLC_Design>
  <Total_Length>34.67</Total_Length>
  <Urban_Area>Skopje</Urban_Area>
  <Width_Sidewalk_L>0.50</Width_Sidewalk_L>
  <Width_Sidewalk_R>0.50</Width_Sidewalk_R>
  <Year_Constr>1996</Year_Constr>
  <ID_Crossing_Type>2</ID_Crossing_Type>
```

```
    <ID_Structure_Type>2</ID_Structure_Type>
  </BMS_STRUCTURE>
  <BMS_STRUCTURE_ELEMENTS>
    <Location_Number>1</Location_Number>
    <Remark>Good.</Remark>
    <ID_ECI>2</ID_ECI>
    <ID_Element>1</ID_Element>
    <ID_Location>2</ID_Location>
    <ID_Material>99</ID_Material>
  </BMS_STRUCTURE_ELEMENTS>
  <BMS_STRUCTURE_ELEMENTS>
    <Location_Number>1</Location_Number>
    <Remark>Good.</Remark>
    <ID_ECI>1</ID_ECI>
    <ID_Element>12</ID_Element>
    <ID_Location>3</ID_Location>
    <ID_Material>1</ID_Material>
  </BMS_STRUCTURE_ELEMENTS>
  <BMS_STRUCTURE_ELEMENTS>
    <Location_Number>2</Location_Number>
    <Remark>Good.</Remark>
    <ID_ECI>1</ID_ECI>
    <ID_Element>12</ID_Element>
    <ID_Location>3</ID_Location>
    <ID_Material>1</ID_Material>
  </BMS_STRUCTURE_ELEMENTS>
  <BMS_STRUCTURE_ELEMENTS>
    <Location_Number>1</Location_Number>
    <Remark>Good.</Remark>
    <ID_ECI>1</ID_ECI>
    <ID_Element>15</ID_Element>
    <ID_Location>4</ID_Location>
    <ID_Material>1</ID_Material>
  </BMS_STRUCTURE_ELEMENTS>
  <BMS_STRUCTURE_ELEMENTS>
    <Location_Number>2</Location_Number>
    <Remark>Good.</Remark>
    <ID_ECI>1</ID_ECI>
    <ID_Element>15</ID_Element>
    <ID_Location>4</ID_Location>
    <ID_Material>1</ID_Material>
  </BMS_STRUCTURE_ELEMENTS>
  <BMS_STRUCTURE_ELEMENTS>
    <Location_Number>1</Location_Number>
    <Remark>Good.</Remark>
    <ID_ECI>2</ID_ECI>
```

```
  <ID_Element>2</ID_Element>
  <ID_Location>1</ID_Location>
  <ID_Material>99</ID_Material>
</BMS_STRUCTURE_ELEMENTS>
<BMS_STRUCTURE_ELEMENTS>
  <Location_Number>1</Location_Number>
  <Remark>Poor.</Remark>
  <ID_ECI>3</ID_ECI>
  <ID_Element>26</ID_Element>
  <ID_Location>1</ID_Location>
  <ID_Material>1</ID_Material>
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