



RAW MATERIALS FOR THE
SUSTAINABLE DEVELOPMENT AND THE
CIRCULAR ECONOMY

RecycleBIM

Integrated Planning and Recording Circularity of Construction Materials through Digital Modelling

Seville - 27th May 2022 – Seminar of CircularBIM Project
Miguel Azenha on behalf of the project team



The project intends to make a multi-national and multi-stakeholder effort towards the **creation of an integrated framework for circularity of raw materials of construction**, leveraged on the wealth of information that is brought about by 'Building Information Modelling'.

5 main aspects:

- (i) ...**new methodology of survey of constructions to-be-demolished**...laser scanning towards cost-effective BIM;
- (ii) Set **BIM modelling rules (and information requirements)** for integrated framework
- (iii) create a **IFC-based tool for multi-criteria optimization of deconstruction strategies and materials** -> manages an integrated multi-criteria optimization procedure for deconstruction phasing and strategies, including LCA analysis (with distinct peculiarities when making Design for Deconstruction, or when solely planning the demolition of an existing building);
- (iv) make all the previous developments together with a specific set **of tools for Municipalities** to use in their process of issuing both deconstruction and new building permits based on BIM models (openBIM through IFC) , including local marketplace;
- (v) strategic and optimised use of **recycled demolition waste in 3D printed concrete** for local digital construction practice.

Start: May 2022

Duration: 36 months

Partners:



Universidade do Minho



TECHNISCHE
UNIVERSITÄT
DARMSTADT

Universidade de Vigo



UNIVERSITEIT
STELLENBOSCH
UNIVERSITY



UNIVERSITY of the
WESTERN CAPE



MARTA CAMPOS



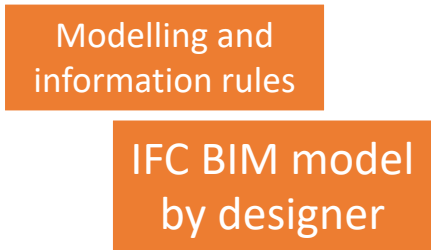
GAIURB,EM
URBANISMO E HABITAÇÃO



World wide free open-source availability

Track: new construction

- EIR template following EN-ISO 19650 and EN 17412:2020
- OpenBIM format IFC



IFC-based tool C# or other

LCA optimization:

- Multi criteria
- Design alternative proposals
- Scenarios of demolition

• 3D printing for circularity

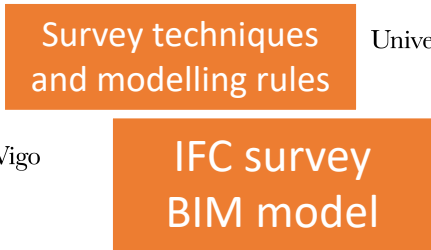
• Viability concerning software

New construction

- Better constructions
 - IFC legacy
 - Townhall database
-

Track: to-be-demolished

- EIR survey template following EN-ISO 19650 and EN 17412:2020
- OpenBIM format IFC



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To-be-demolished

- Database of materials to be available
 - Bidding for reuse (Local based)
-

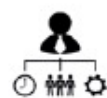


BigData
 Database for machine-learning

Data Warehouse
 for online market
 (GDPR Awareness)



Reviewing WPs and planning



Nº	Partner name/acronym	Coordination and management		BIM data specifications		SCAN-to-BIM		IFC based tool		3D printing and new opp. for circularity		Database proposals and case studies		Communication and dissemination		Country/region	Person-month
		WP1	WP2	WP3	WP4	WP5	WP6	WP7									
1	Univ. Minho / UMinho	L	7	L	27.5	CoL	10	CoL	10.2	P	3	P	8.5	L	7	Portugal	73.2
2	TU Darmstadt / TUDa	CoL	3	P	2	P	2	L	19	P	3	P	4	CoL	3	Germany	36
3	Univ. Vigo / UVIGO	sp	1	CoL	15	L	31	P	8	sp	0.5	P	8	sp	3.1	Spain	66.6
4	Univ. Stellenbosch / SU	sp	1	P	5.25	O	0	P	13.5	L	65.5	P	23.25	sp	2.5	S. Africa	111
5	ACCA Software / ACCA	P	2.25	P	18	P	14.8	P	12	O	0	CoL	36.55	P	11.8	Italy	95.4
6	SHW Messel / SHW	sp	1	O	0	O	0	P	7	P	5	P	6.5	sp	1	Germany	20.5
7	Univ. Western Cape / UWC	sp	1.5	P	3.75	sp	1	sp	1.25	CoL	44	P	6.5	sp	5	S. Africa	63
8	LEZAMA/Tecnalia / LEZ	sp	1	sp	5.5	sp	7	sp	5	sp	1	L	10	P	3	Spain	32.5
9	Lafarge Holcim / LHol	sp	1	P	4	O	2	P	2.8	P	1.8	P	5.4	sp	1	France	18
10	Newton Consult. / NWT	O	0	O	0	O	0	O	0	O	0	P	5	sp	1	Portugal	6
11	Marta Campos / MCA	O	0	O	0	O	0	O	0	O	0	P	5	sp	1	Portugal	6
12	Gaiurb EM, GUR	O	0	O	0	O	0	O	0	O	0	P	1	sp	1	Portugal	2

L - Leader; CoL - CoLeader; P - Strong participant; sp - small participant; O - Observer

	1	2	3	4	5	6	7	8	9	10	11	12
	Year 1											
	1	2	3	4	5	6	7	8	9	10	11	12
WP1 - Coordination and Management	Ms1.1		Ms1.2			Ms1.3						
T1.1 - Kick off meeting and definition of boards						D1.2						
T1.2 - Regular project meetings, communication, follow-up						D1.3						D1.3
T1.3 - Management of project quality and results			D1.1			D1.4						D1.4
T1.4 - Internal and Contractual Reporting												D1.5
T1.5 - Coordinating the exploitation of results												

WP2 - BIM Data specifications												
T2.1 - Product Data Templates								D2.1				
T2.2 - Level of Information Need												D2.2
T2.3 - Exchange Information Requirements												
T2.4 - BIM Execution Plan and Modelling Guides												
T2.5 - Interoperability												

WP3 - Developing cost-effective SCAN-to-BIM for pre-demolition								Ms3.1				
T3.1 - Survey planning for constructions to be demolished								D3.1				
T3.2 - Geospatial data processing												
T3.3 - Building Element Parametrization												
T3.4 - Generation of IFC-compliant models to assist BIM creation												

WP4 - IFC-based tool for optimisation and scenario studying												
T4.1 - Developing an access strategy IFC-databases												
T4.2 - IFC-based operational energy demand assessment tool												
T4.3 - CDW prediction model												
T4.4 - Advanced LCA-LOC objective function based optimization tool												




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WP5 - 3D printing and new opportunities for circularity						Ms5.1						Ms5.2
T5.1 - Inventory of recycled waste for 3DCP	 UNIVERSITEIT iYUNIVESITHI STELLENBOSCH UNIVERSITY											D5.1
T5.2 - Concrete technology for high-quantity waste recycling												
T5.3 - Mix design guidelines for R-3DPC												
T5.4 - Mechanical and durability characterisation of R-3DPC												
T5.5 - High quality R-3DPC products												

WP6 - Database proposals and case studies												
T6.1 - Marketplace for recycled materials from CDW												
T6.2 - Case studies												
T6.3 - Analysis in terms of circularity and costs												

WP7 - Communication, dissemination and exploitation						Ms7.2			Ms7.1				
T7.1 - Scientific progress presentations at biannual meeting						D7.1						D7.1	
T7.2 - RecycleBIM dissemination and data management plan									D7.2				
T7.3 - Scientific Publications													
T7.4 - RecycleBIM website and social networks				D7.4									
T7.5 - Public dissemination													
		1	2	3	4	5	6	7	8	9	10	11	12
		Year 1											
		1	2	3	4	5	6	7	8	9	10	11	12

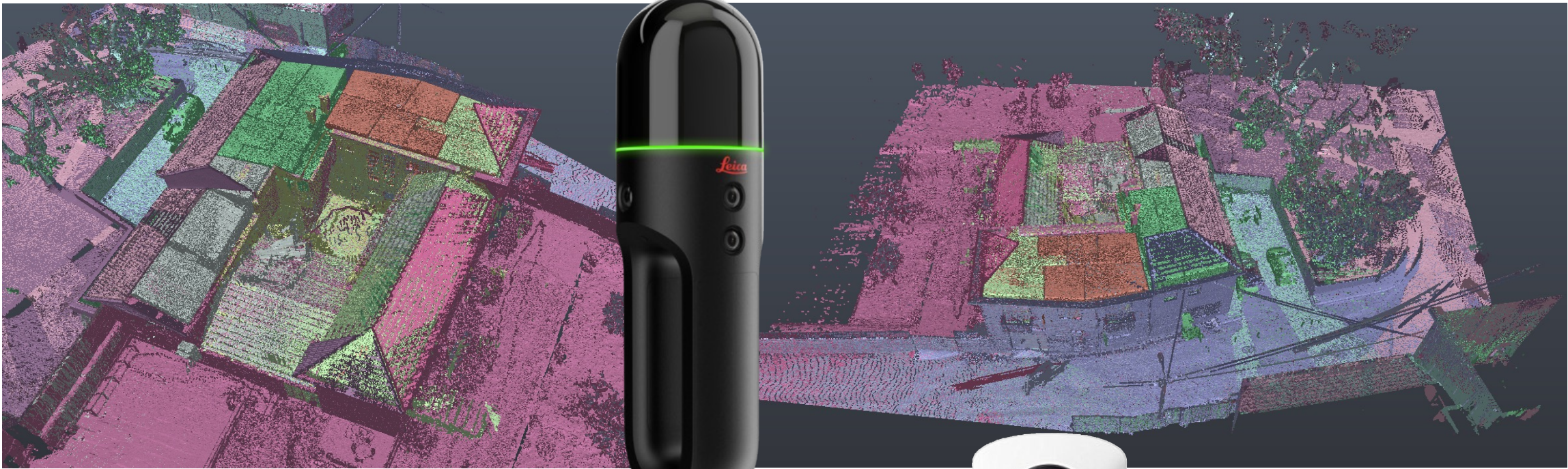


Some work conducted
so far...

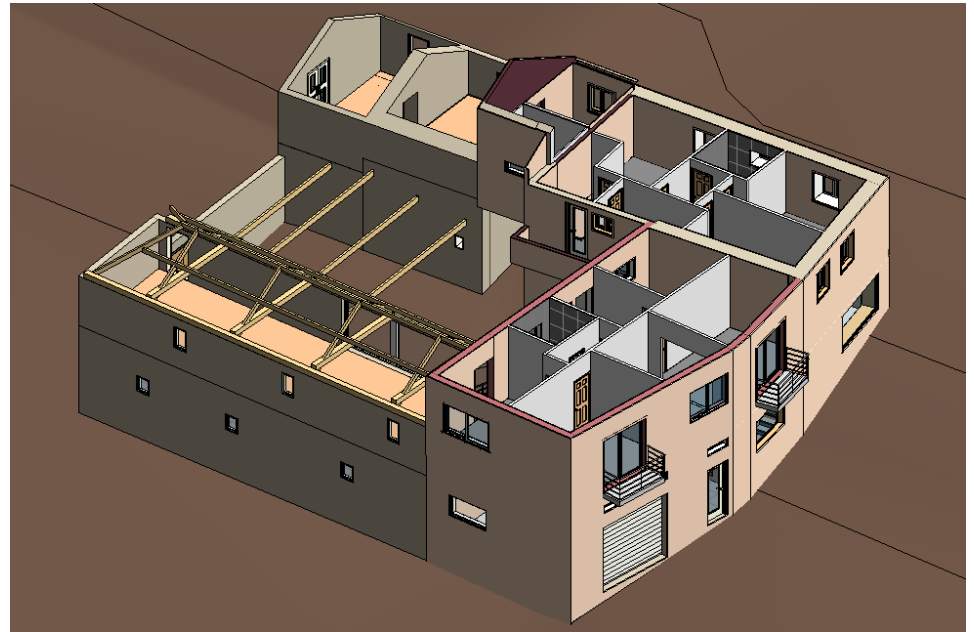
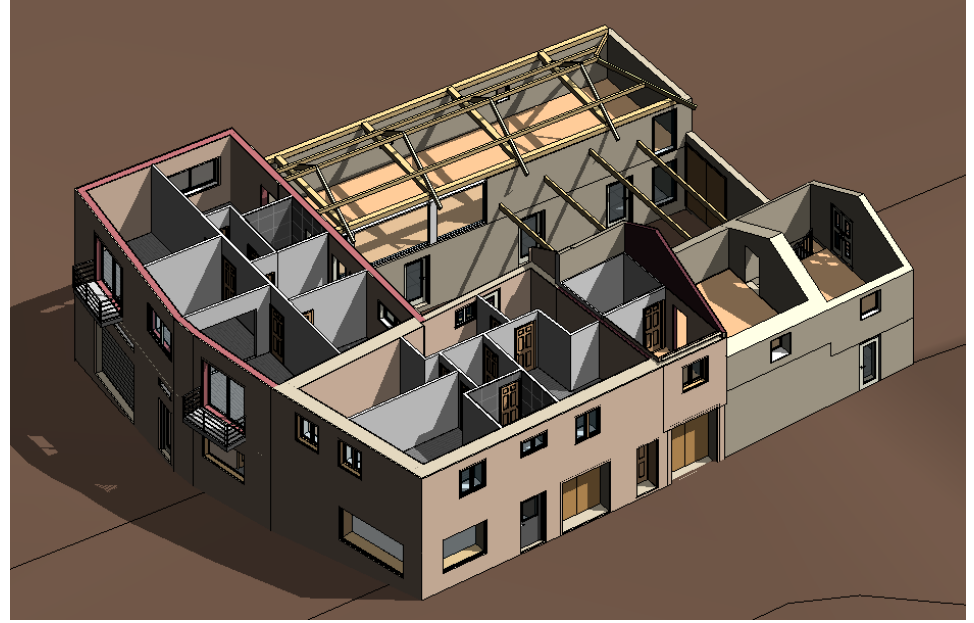
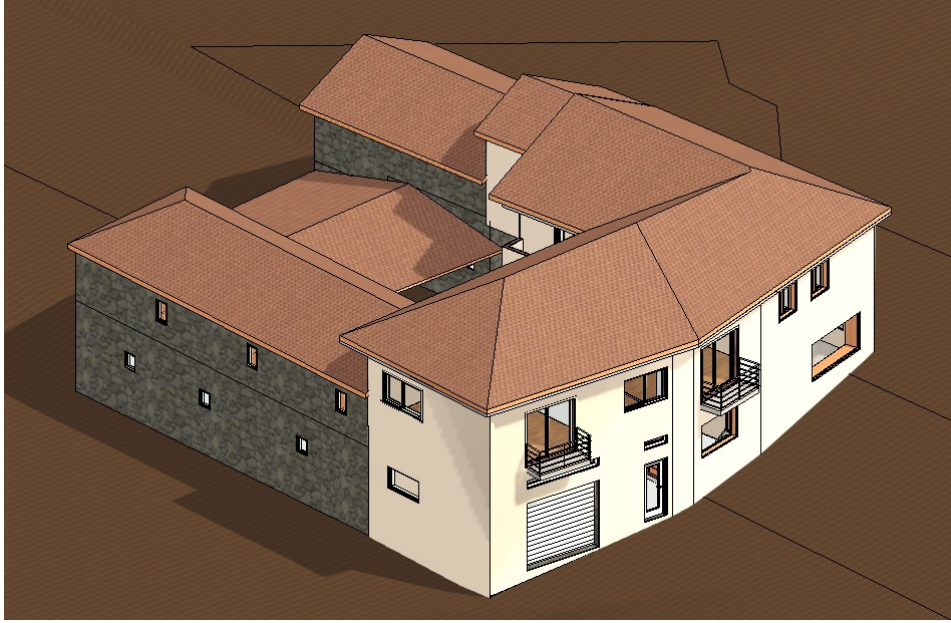
THE CASE STUDY



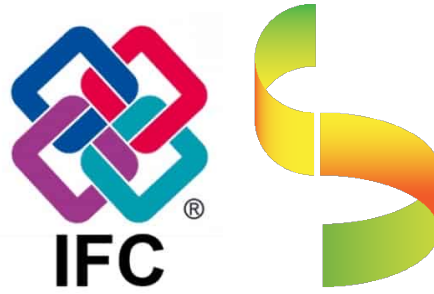
SURVEY



BIM MODEL



IFC-based WEB FRAMEWORK



```
import math
import sys
import json
import ifcopenshell
import ifcopenshell.util
import ifcopenshell.util.element
import ifcopenshell.util.selector
import ifcopenshell.util.pset

phpinput = str(sys.argv[1])

bld_elems_classes = ["IfcBeam", "IfcColumn", "IfcCovering", "IfcCurtainWall", "IfcDoor", "IfcFooting", "IfcMember",
                    "IfcPile", "IfcPlate", "IfcRailing", "IfcRamp", "IfcRampFlight", "IfcRoof", "IfcSlab",
                    "IfcStairFlight", "IfcWall", "IfcWindow", "IfcStair", "IfcChimney", "IfcShadingDevice"]

ifc = ifcopenshell.open('uploads/'+str(phpinput))

# print(ifc.by_type("IfcProject")[0].UnitsInContext.Units)
bld_elems = []
present_classes = []
elems_wo_pset_ids = []
present_elems_ids = []
lst_text = []
for i in range(len(bld_elems_classes)): # filtering present classes and populating list of present classes
    cl_elems = ifc.by_type(bld_elems_classes[i])

    if len(cl_elems) != 0:
        present_classes.append(bld_elems_classes[i])
        bld_elems.append(cl_elems)

<script type="module">
// -----
// Import the modules we need for this example
// -----
import {
    Viewer,
    XKTLoaderPlugin,
    NavCubePlugin,
    TreeViewPlugin
} from "./dist/xeokit-sdk.min.es.js";

// -----
// Create a Viewer, arrange the camera, tweak x-ray and highlight materials
// -----

const viewer = new Viewer({
    canvasId: "my-Canvas",
    transparent: true
});
const cameraControl = viewer.cameraControl;
const scene = viewer.scene;
const cameraFlight = viewer.cameraFlight;

cameraControl.followPointer = true;
cameraControl.doublePickFlyTo = true;
cameraFlight.duration = 1.0;
cameraFlight.fitFOV = 25;

viewer.camera.eye = [-2.56, 8.38, 8.27];
viewer.camera.look = [13.44, 3.31, -14.83];
viewer.camera.up = [0.10, 0.98, -0.14];
```

Upload your model (IFC file)

Choose File No file chosen

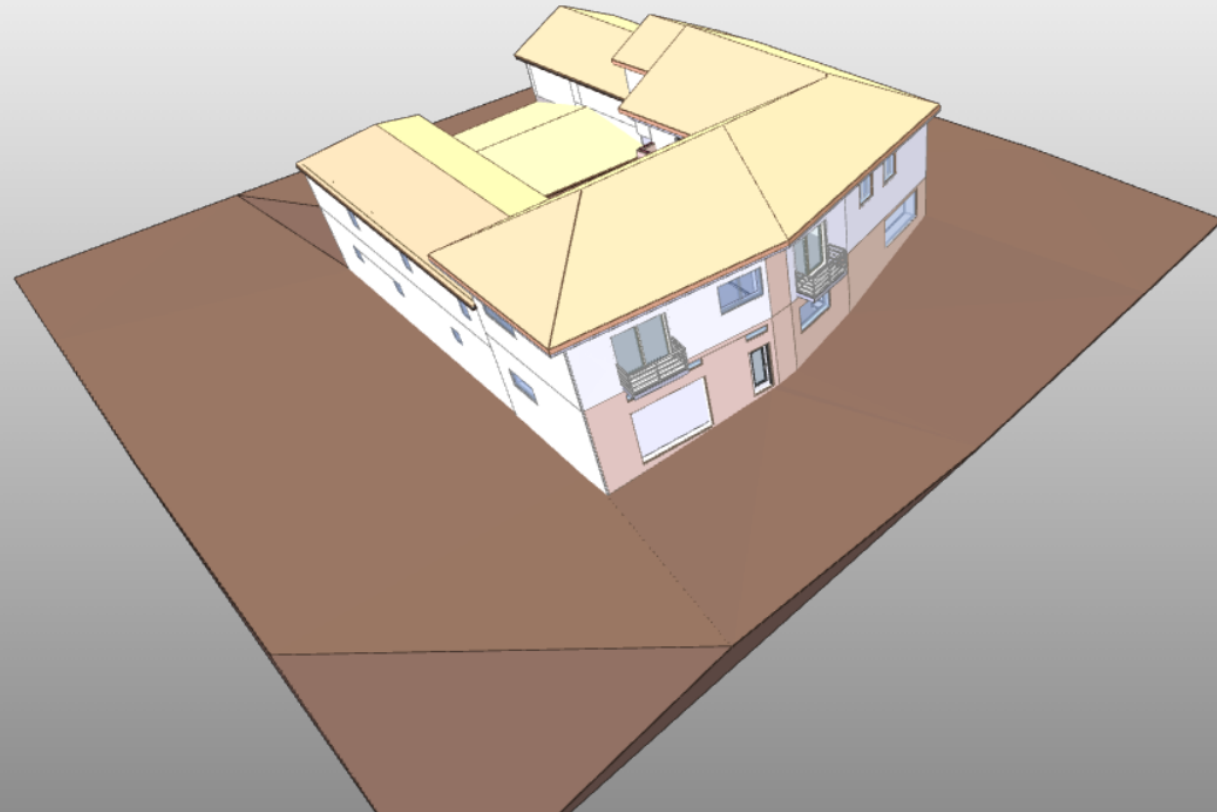
UPLOAD

Show the model

628e9bbc44b635.88352887

SHOW THE MODEL

- 0001
 - + IfcBeam
 - + IfcBuildingElementProxy
 - + IfcDoor
 - + IfcMember
 - + IfcPlate
 - + IfcRailing
 - + IfcRoof
 - + IfcSite
 - + IfcSlab
 - + IfcStairFlight
 - + IfcWall
 - + IfcWindow



RecycleBIM MANUAL UPLOAD & VIEW THE PROJECT VALIDATE & SEND TO THE MARKET LOG OUT

Show the model (reference)
628e9bbc44b635.88352887

Validation

Check for missing Property sets
 Check for inconsistent arrays
 Show manually estimated elements
 Show elements that can be reused

SHOW THE MODEL | RUN

CHEK PROJECT LOCATION

Project information
628e9bbc44b635.88352887

Type of building:
Residential

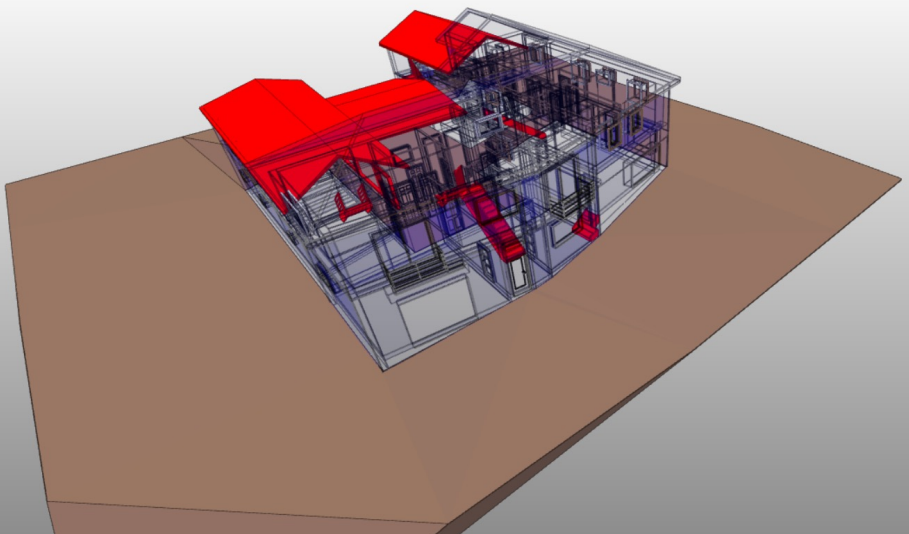
Year of construction:
1961-1990

Available documentation:
Link to available documentation

Demolition start date:
07/17/2022

I am informed and agree with:
 - The elements that did not pass validation will not be processed.
 - The location of the project is correct.
 - The model will be sent to the market

SEND THE DATA



```

report (1).txt - Notepad
File Edit Format View Help

"IfcPlate - 79 element(s). Circularity properties are filled: 6%"
"NOTE: For the class IfcPlate 78 elements (99% ) have parent elements, 50% of them have Circularity properties"

"IfcRailing - 6 element(s). Circularity properties are filled: 34%"
"NOTE: For the class IfcRailing 6 elements (100% ) have parent elements, 34% of them have Circularity properties"

"IfcRoof - 1 element(s). Circularity properties are filled: 100%"

"IfcSlab - 1 element(s). Circularity properties are filled: 100%"

"IfcStairFlight - 3 element(s). Circularity properties are filled: 0%"
"NOTE: For the class IfcStairFlight 3 elements (100% ) have parent elements, 34% of them have Circularity properties"

"IfcWall - 32 element(s). Circularity properties are filled: 72%"

"IfcWindow - 10 element(s). Circularity properties are filled: 100%"

"IfcStair - 3 element(s). Circularity properties are filled: 34%"
    
```

RecycleBIM MANUAL UPLOAD & VIEW THE PROJECT VALIDATE & SEND TO THE MARKET LOG OUT

Show the model (reference)
628e9bbc44b635.88352887

Validation

Check for missing Property sets
 Check for inconsistent arrays
 Show manually estimated elements
 Show elements that can be reused

SHOW THE MODEL | RUN

CHEK PROJECT LOCATION

Project information
628e9bbc44b635.88352887

Type of building:
Residential

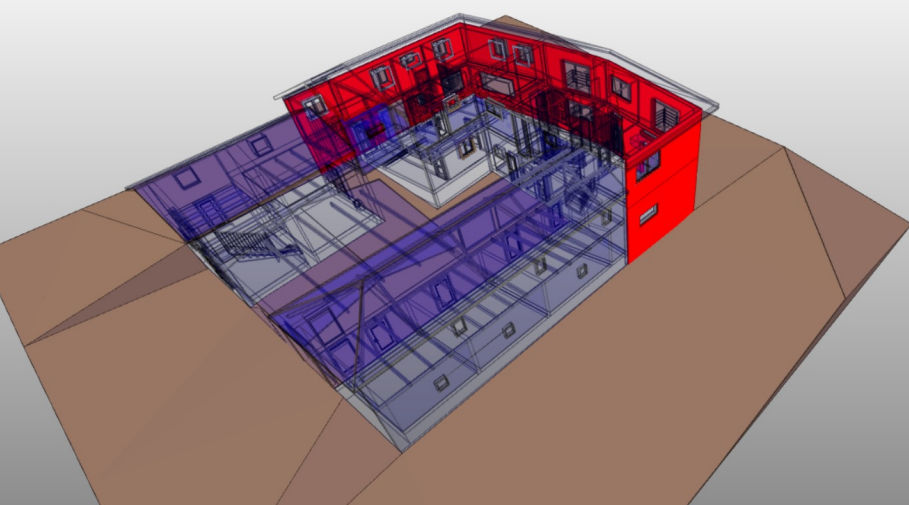
Year of construction:
Before 1919

Available documentation:
Link to available documentation

Demolition start date:
07/17/2022

I am informed and agree with:
 - The elements that did not pass validation will not be processed.
 - The location of the project is correct.
 - The model will be sent to the market

SEND THE DATA



```

report (2).txt - Notepad
File Edit Format View Help

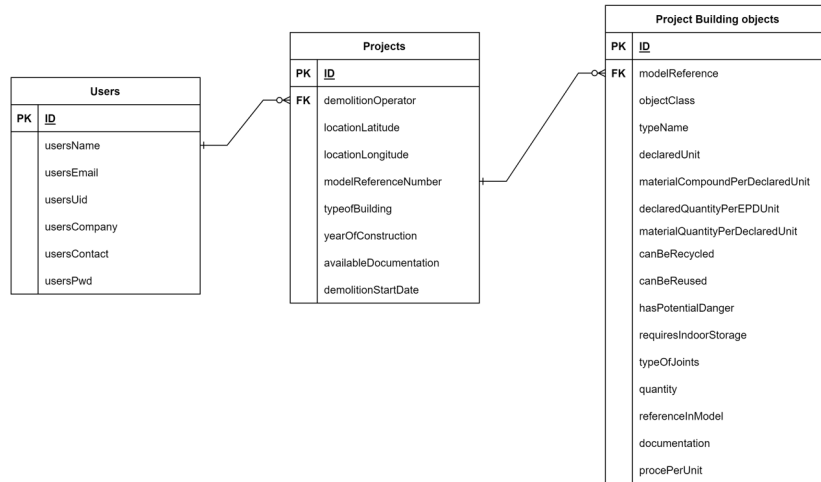
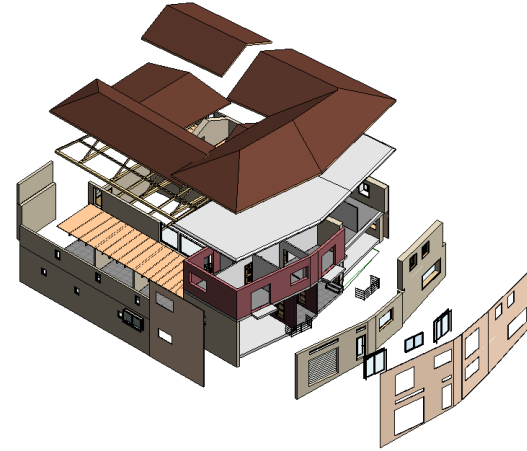
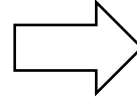
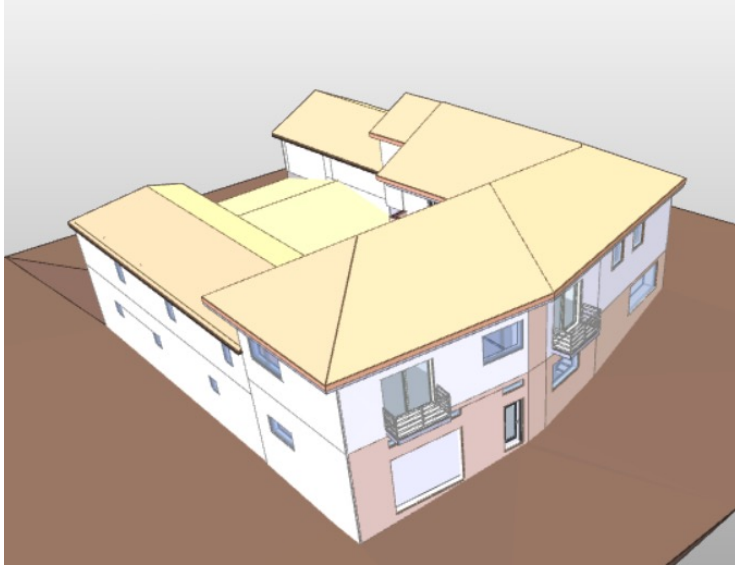
"IfcSlab - inconsistency in array properties. GUID: 1XTu0S5VncSBs9uZvsrs9J.
Check values: concrete,steel | 2100 | 17_01_07"

"IfcWall - inconsistency in array properties. GUID: 1XTu0S5VncSBs9uZvsrs5D.
Check values: concrete,steel | 2100 | 17_01_07"
"IfcWall - inconsistency in array properties. GUID: 1XTu0S5VncSBs9uZvsrs32.
Check values: concrete,steel | 2100 | 17_01_07"

The list of questioned elements:

"1XTu0S5VncSBs9uZvsrs9J", "1XTu0S5VncSBs9uZvsrs5D", "1XTu0S5VncSBs9uZvsrs32"
    
```

IFC-based WEB FRAMEWORK



Server: 127.0.0.1 » Database: phpproject01 » Table: projectbuildingobjects

modelReference	objectClass	typeName	declaredUnit	declaredQuantityPerUnit	materialCompounPerDeclareUnit	materialQuantityPerDecl
28 6278fe33ce25f6 61259953	IfcBeam	UB-Universal Beams: UB305x165x40	m	1.0	steel	30
29 6278fe33ce25f6 61259953	IfcColumn	UC-Universal Columns-Column: UC305x305x97	m	1.0	steel	30
30 6278fe33ce25f6 61259953	IfcColumn	UC-Universal Columns-Column: UC305x305x97	m	1.0	steel	30
31 6278fe33ce25f6 61259953	IfcCovering	Floor: AK_Floor_Screed_60	m2	1.0	screed	50
32 6278fe33ce25f6 61259953	IfcCovering	Floor: AK_Floor_Screed_60	m2	1.0	screed	50
33 6278fe33ce25f6 61259953	IfcCovering	Floor: AK_Floor_Plywood_20	m2	1.0	plywood	30
34 6278fe33ce25f6 61259953	IfcCovering	Floor: AK_Floor_Plywood_20	m2	1.0	plywood	30
35 6278fe33ce25f6 61259953	IfcDoor	M_Single-Flush: 0915 x 2134mm	pcs	1.0	wood_iron	15,2
36 6278fe33ce25f6 61259953	IfcDoor	M_Single-Flush: 0813 x 2134mm	pcs	1.0	wood_iron	15,2
37 6278fe33ce25f6 61259953	IfcDoor	M_Single-Flush: 0813 x 2134mm	pcs	1.0	wood_iron	15,2
38 6278fe33ce25f6 61259953	IfcRailing	Railing: 1100mm	m	1.0	wood	20
39 6278fe33ce25f6 61259953	IfcRailing	Railing: 1100mm	m	1.0	wood	20
40 6278fe33ce25f6 61259953	IfcSlab	Floor: AK_Floor_RC_150	m3	1.0	concrete,steel	2100
41 6278fe33ce25f6 61259953	IfcWall	Basic Wall: AK_Wall_RC_150	m3	1.0	concrete,steel	2100

Thank you!

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Seville - 27th May 2022 – Seminar of CircularBIM Project

