



GTB LAB demonstrates

- Circular building design
- Construction without value degradation of materials
- Circular building methods
- Use of digital tools/ BIM for management of circular material streams
- Standardisation of Circularity profiles

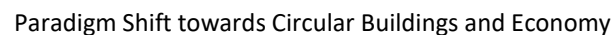


4D
architects

Architect: E.Durmisevic, 4D Architects
Constructeur: J.van Heijster, AB
Installatie: J.Widenhof, ABT
Aanmeer : Jongen Bouw
Leveranties: De Groot Vroomshoop, Jansen/ODS, Pilkinton, TNM, Rodeca, Ammanu



*Elma Durmisevic, EU BAMB 2020, circular economy in construction
Design strategies for reversible buildings, 2019*



Multiple layers of buildings enable multiple value propositions by reversible design ©E.Durmisevic 2016



Buildings frequently undergo Demolition due to :

- degradation of materials and more technology dependent components
- Inability to remove and exchange building systems and components
- unfitted for recycling
- difficult to repair
- difficult to access
- difficult to deconstruct

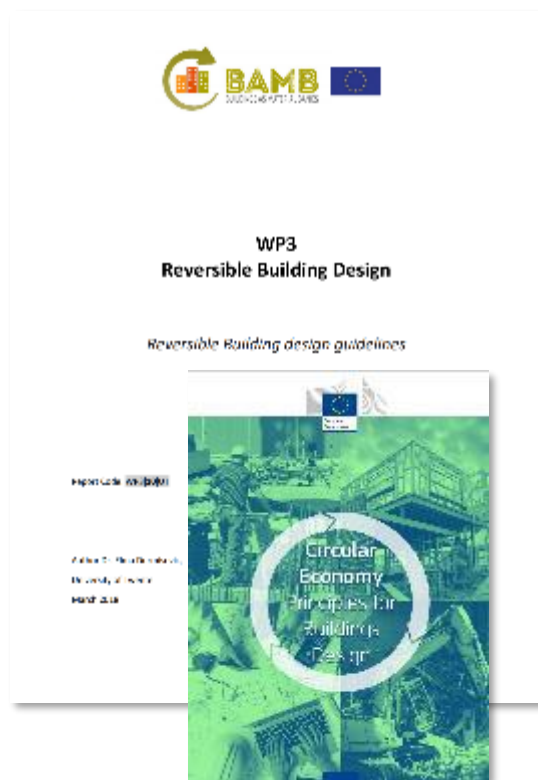


- 40% CO2 emission in world is building related
- 50% of material resources taken from the nature are building related
- over 39% of national waste production comes from the building sector



Reversible Building Design Dimensions

Towards reversible BIM
©Model Durmisevic 2015



THREE DESIGN DIMENSIONS OF REVERSIBLE BUILDINGS

Elma Durmisevic,

Ensure multiple value propositions of Building through three dimensions of building's reversibility

Spatial Reversibility
Building Reuse

1



Reversibility of space
Adapt space

2



Reversibility of structure/
Reconfigure /upgrade structure

3

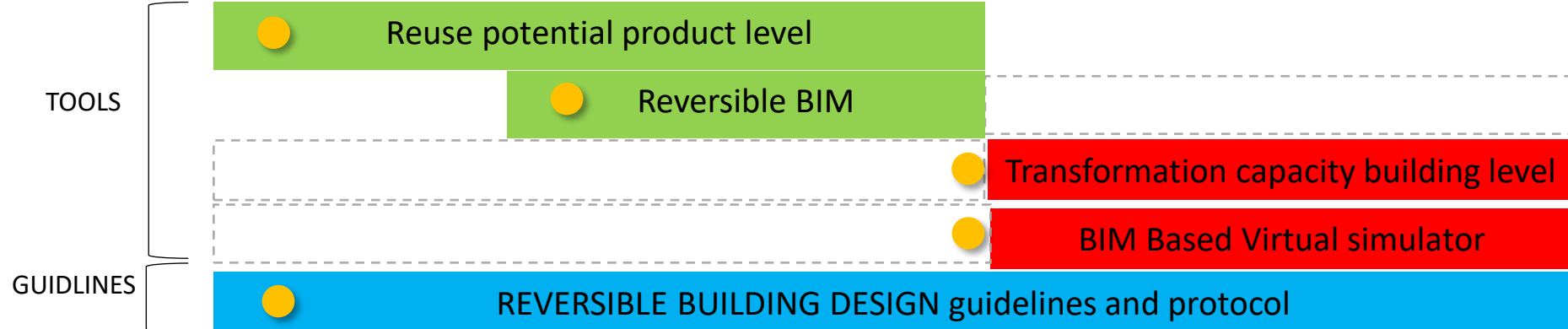
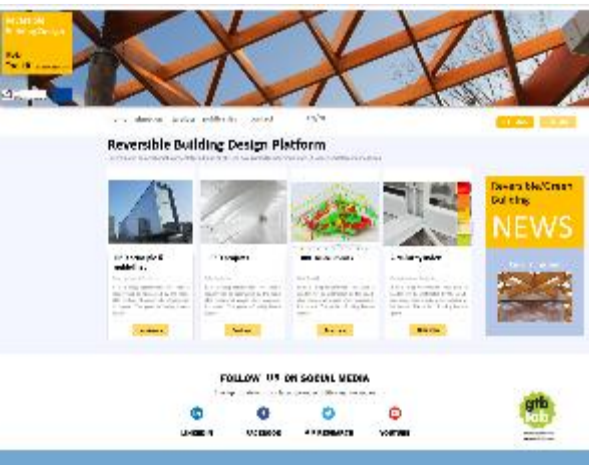


Reversibility of material/
Separate elements/ material

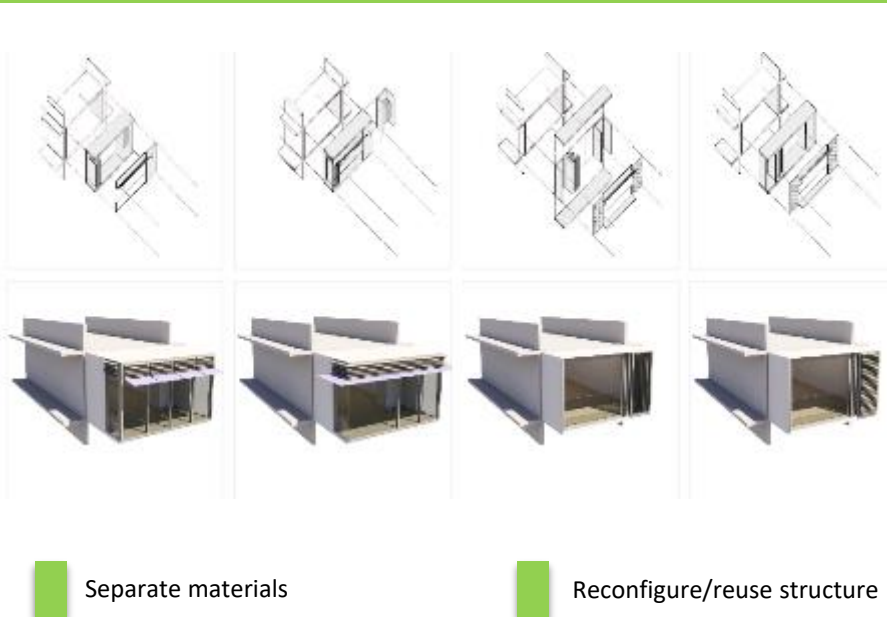
Dr. Elma Durmisevic, BAMB program/research leader of Reversible Building Design group, 4D architects founder GTB lab & GDC SGDF

Reversible Building Design and Assessment Toolkit

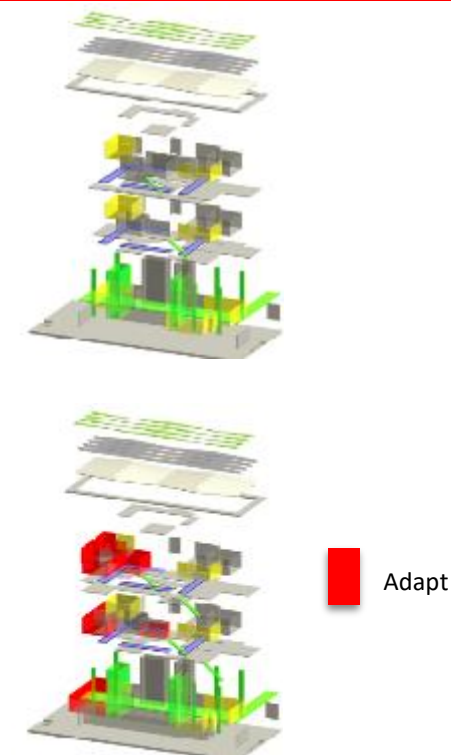
©Model Durmisevic 2015



Technical Reversibility



Spatial Reversibility



Reversible Building

Circularity profile 0

RBD Category 0

Spatial reversibility
TC 0,1

Technical reversibility
RP 0,1

High value reuse less than 10 %
&
Downcycling more than 50%

Reversible Building

Circularity profile 1

RBD Category 1

Spatial reversibility
TC 0,2 & 0,3

Technical reversibility
RP 0,2 & 0,3

Reuse Building structure 15 to 39%
/
High value materials reuse 10-15% & Recycling more than 50%

Reversible Building

Circularity profile 2

RBD Category 2

Spatial reversibility
TC 0,4 & 0,5

Technical reversibility
RP 0,2 & 0,3

Reuse Building structure 15 to 39%

High value materials reuse 15-39%

Reversible Building

Circularity profile 3

RBD Category 3

Spatial reversibility
TC = 0,4 to 0,6

Technical reversibility
RP 0,4 to 0,6
TC > 0,7 RP 0,3
RP > 0,7 TC < 0,3

Reuse Building structure 40-69%

High value materials reuse 40-69%

Reversible Building

Circularity profile 4

RBD Category 4

Spatial reversibility
TC > 0,7

Technical reversibility
RP > 0,7

Reuse Building structure more than 70%
Materials reused more than 70%

Circularity Profile based on Reversibility Indicators = Reuse Capacity of Buildings and its Materials



Reuse potential product level



Transformation capacity building level



Virtual simulator



REVERSIBLE BUILDING DESIGN protocol

Technical Reversibility

Spatial Reversibility



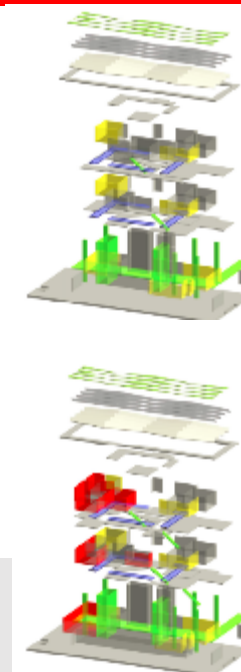
Separate materials



Reconfigure structure



Adapt



REVERSIBLE BUILDING

Technical Reversibility

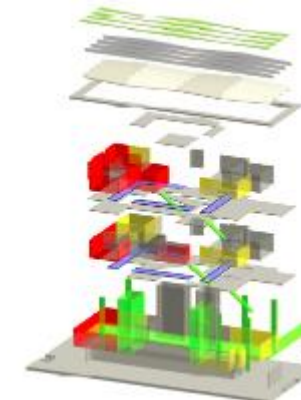
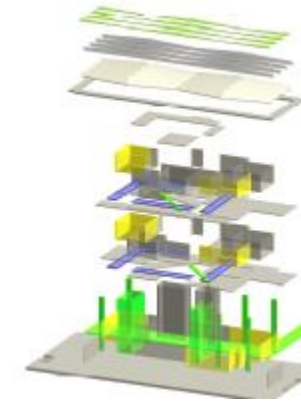
Spatial Reversibility



Separate materials



Reconfigure structure



Adapt space

© E.Durmisevic 2016

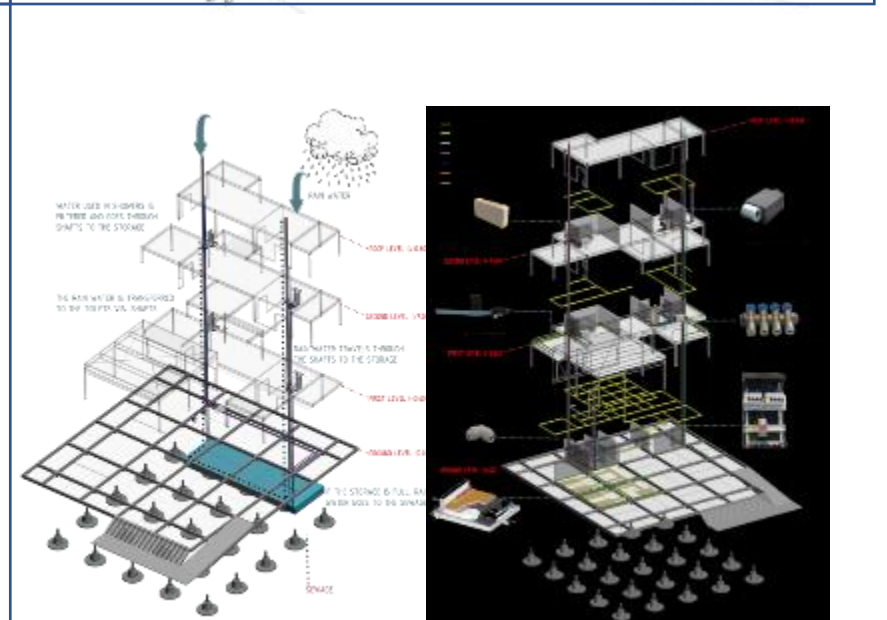
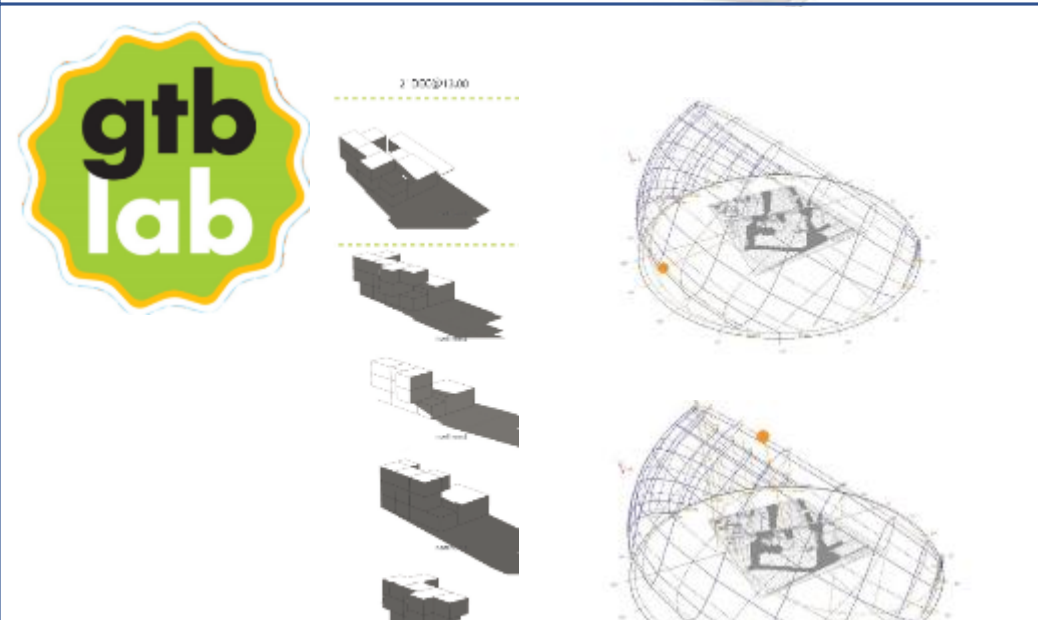
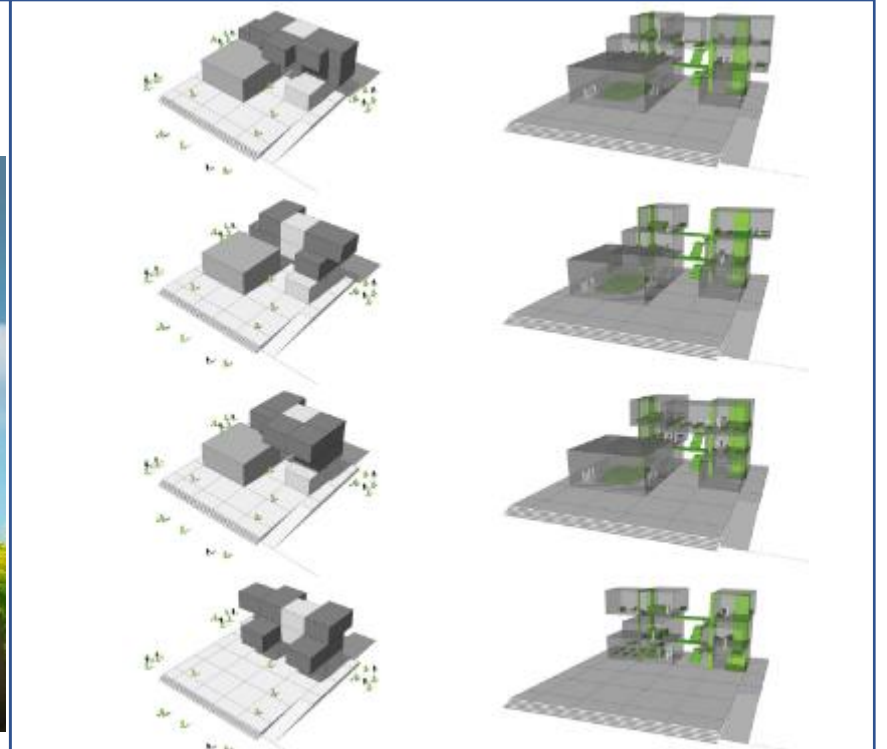


SPACE

Green Transformable BuildingLab



© Elma Durmisevic



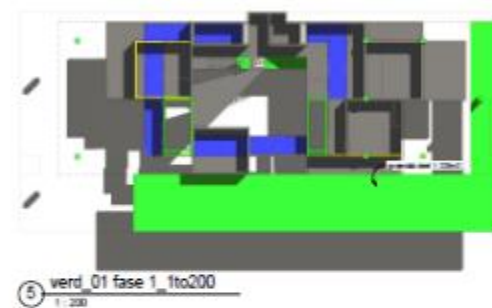
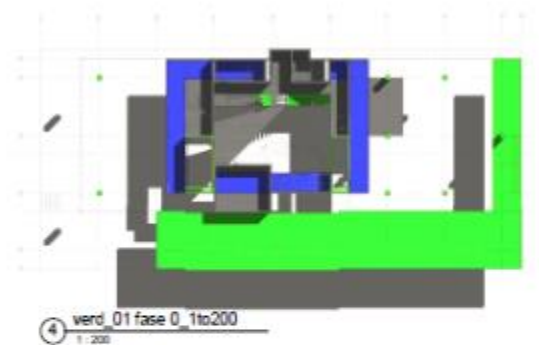
Elma Durmisevic | Reversible Buildings, The Netherlands

4D architects

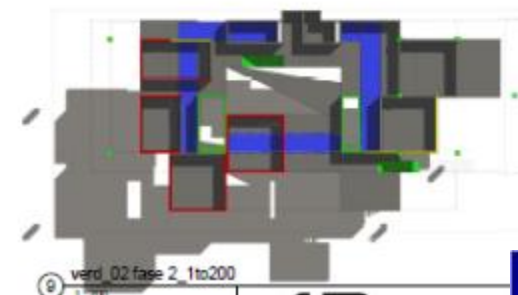
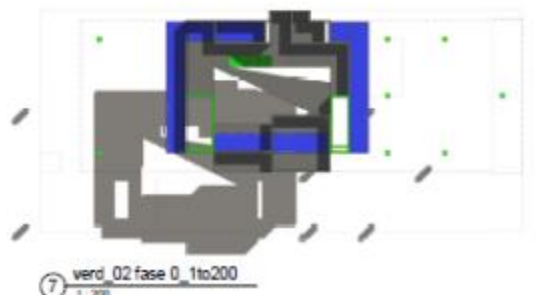


SPACE

FIRST FLOOR



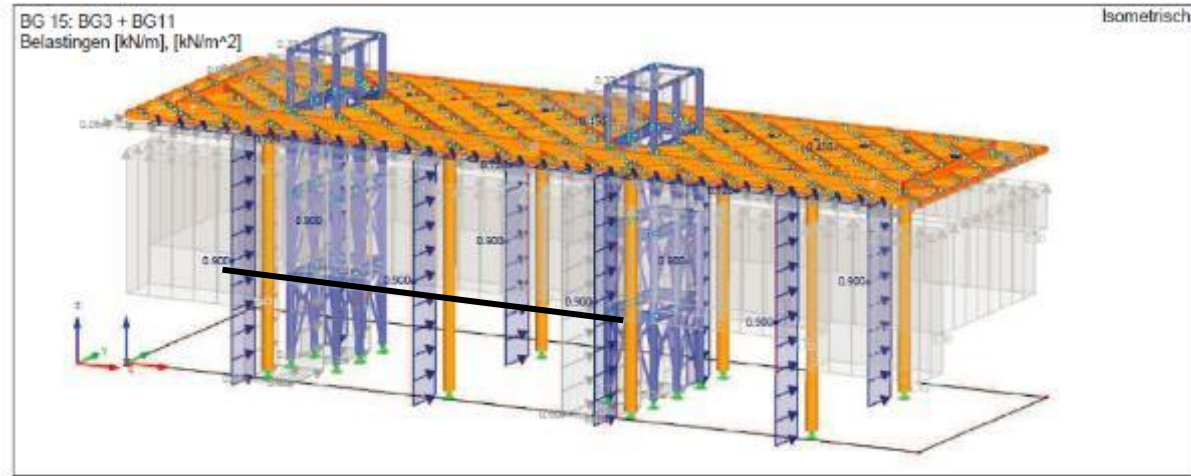
THIRD FLOOR



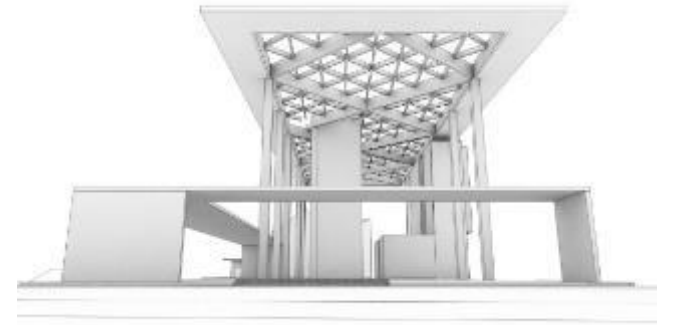
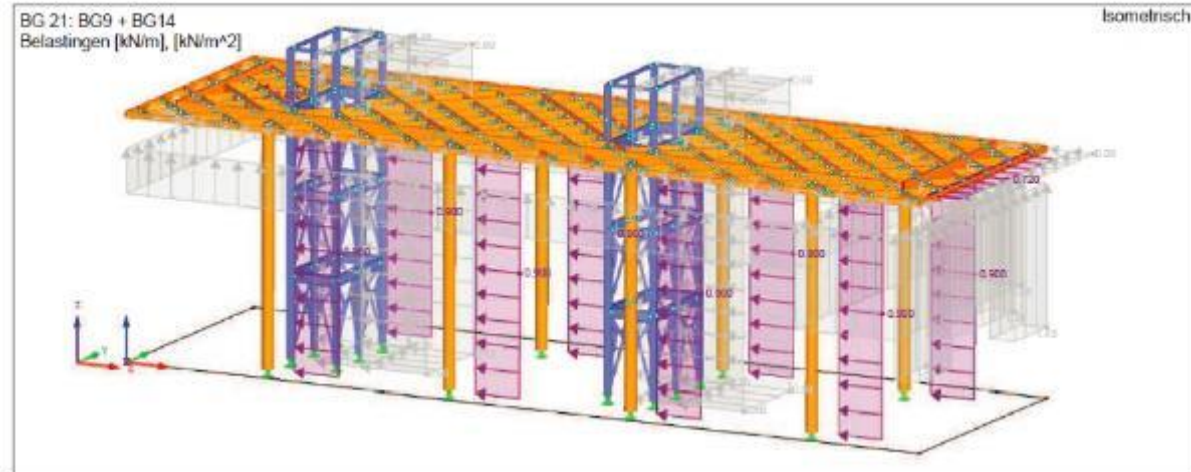
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SPACE

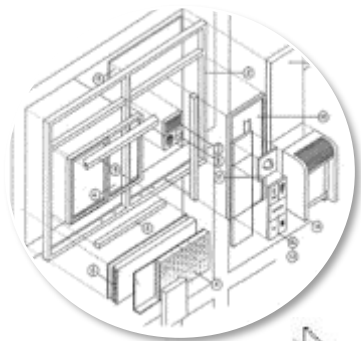


Figuur 5, Wind dak 0.75 kN/m² (basis ⊥)



The core

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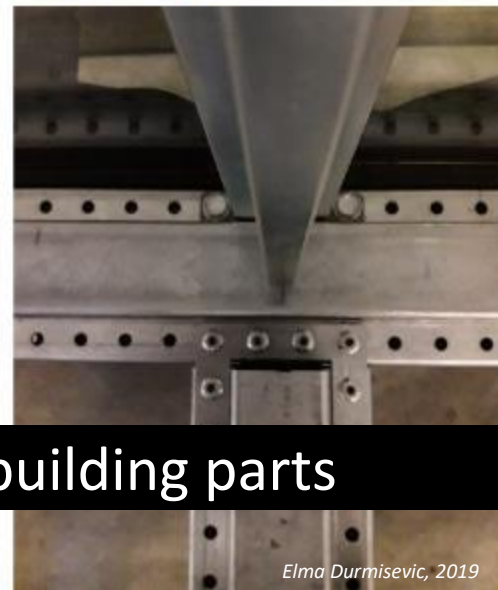


STRUCTURE



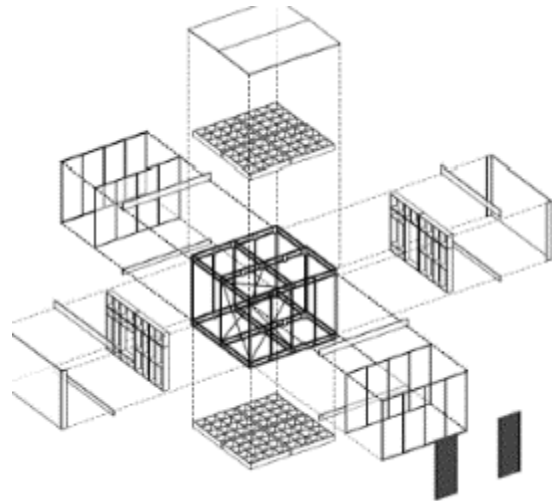
Demonstration of a new Building Generation Strat here –GTBL

www.greentransformablebuildings.com



Exchangability of building parts

Demonstration of circular solution



4D
architects

kloeckner metals

ODS Nederland

JANSEN

SKELIT

PILKINGTON

TNI
THE NEW MAKERS

rodeca
Transport & Bouwmaterialen

4D
architects



datum
08/2017

Project fase
DO fase

Opdracht

Regio Parkstad | Heerlen

Circular Building

Design of high reuse potential



MATERIAL

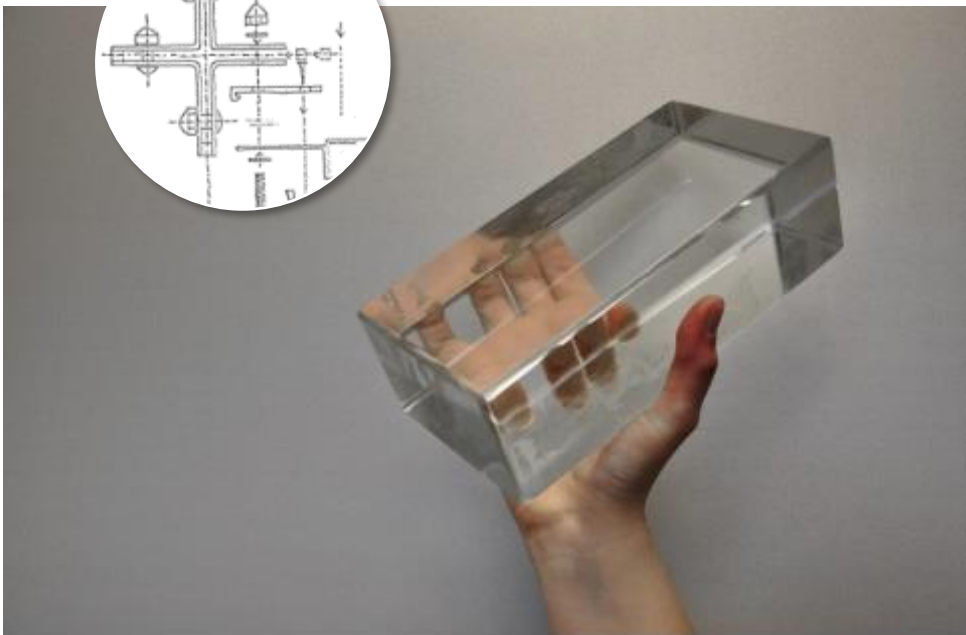
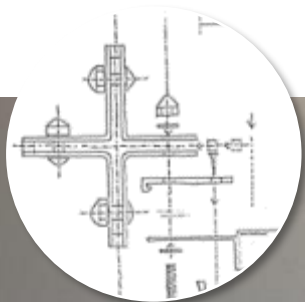
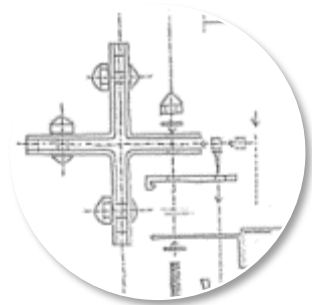
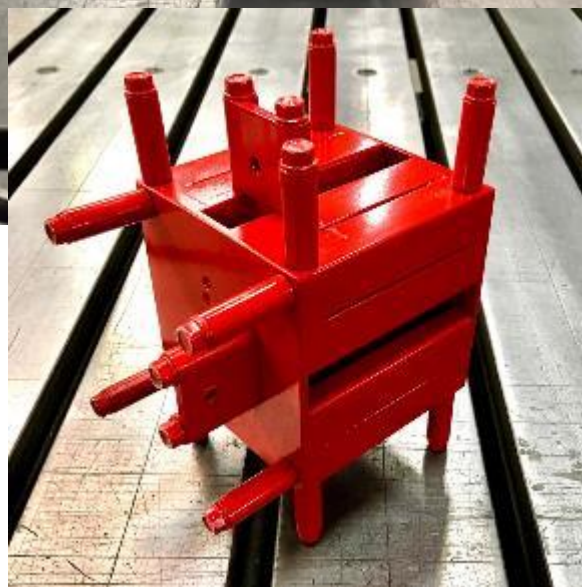
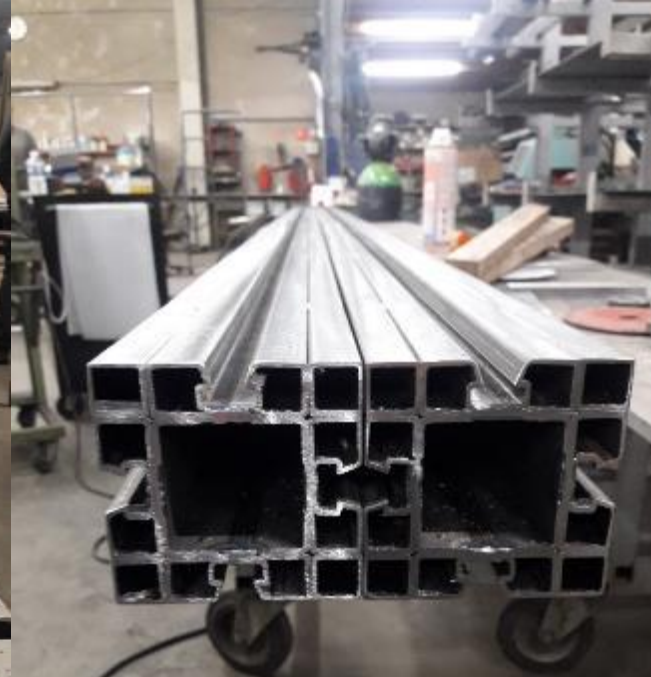
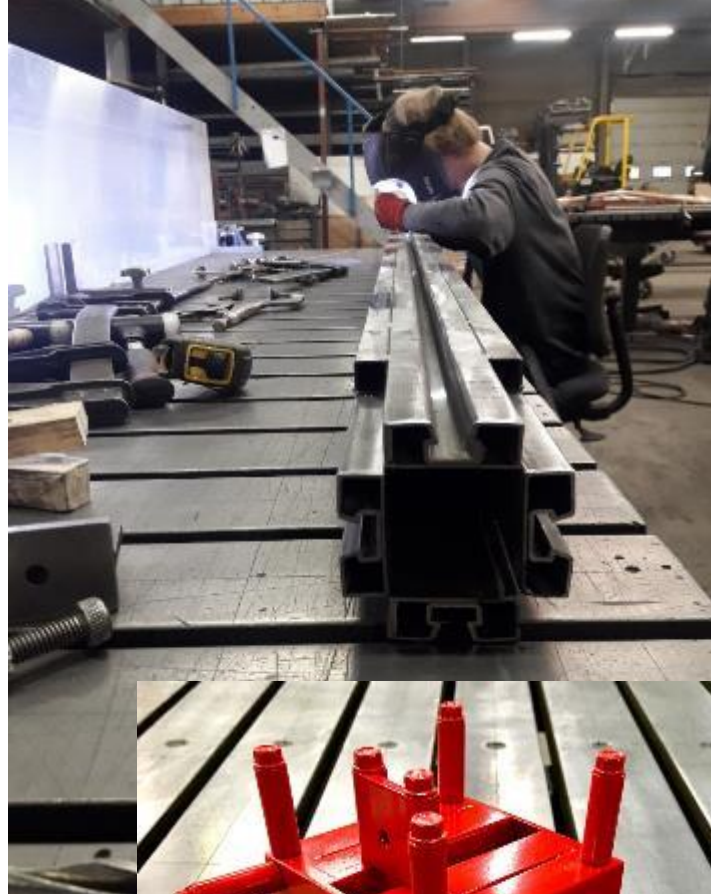


Photo by Faidra Oikonomopoulou





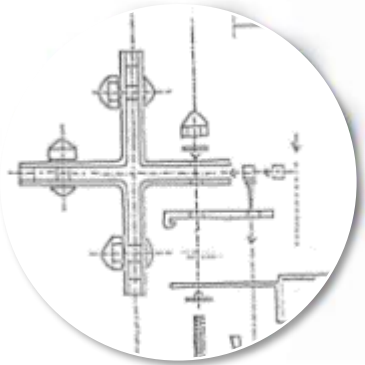
MATERIAL



ODS
klöckner & co multi metal distribution

JANSEN

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MATERIAL



Eliminate waste



GTB Lab

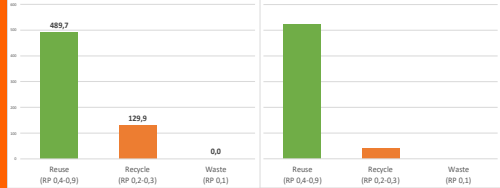
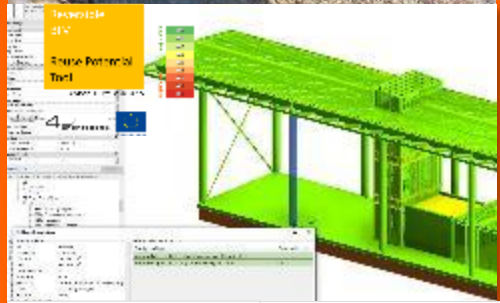
Irreversible Building
Circularity Profile 0

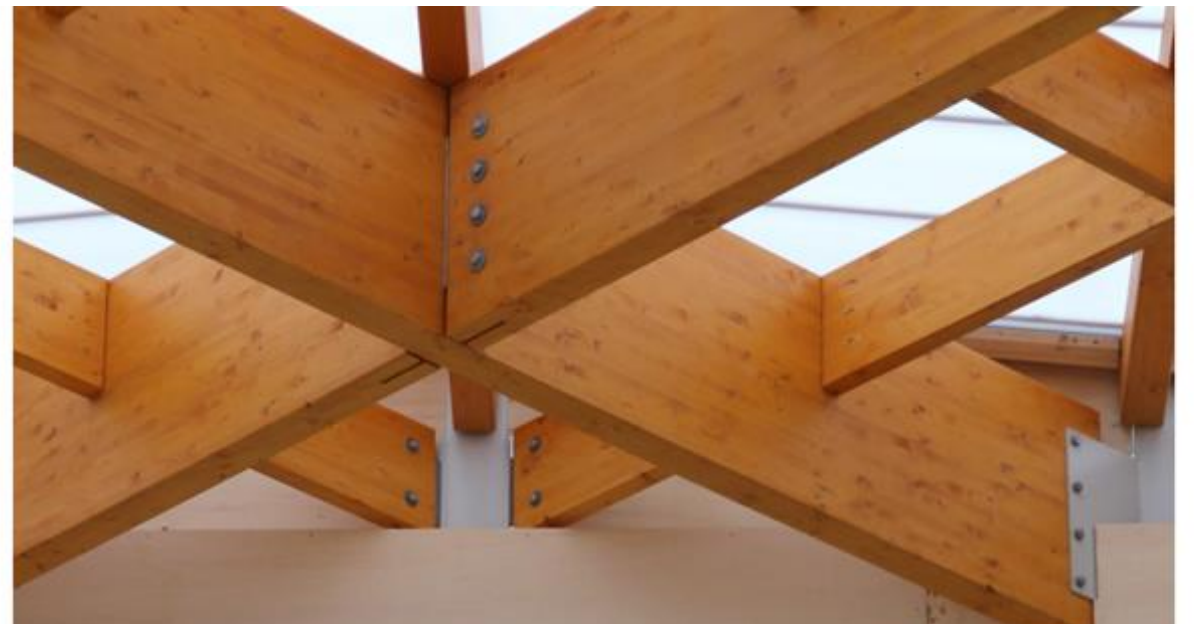
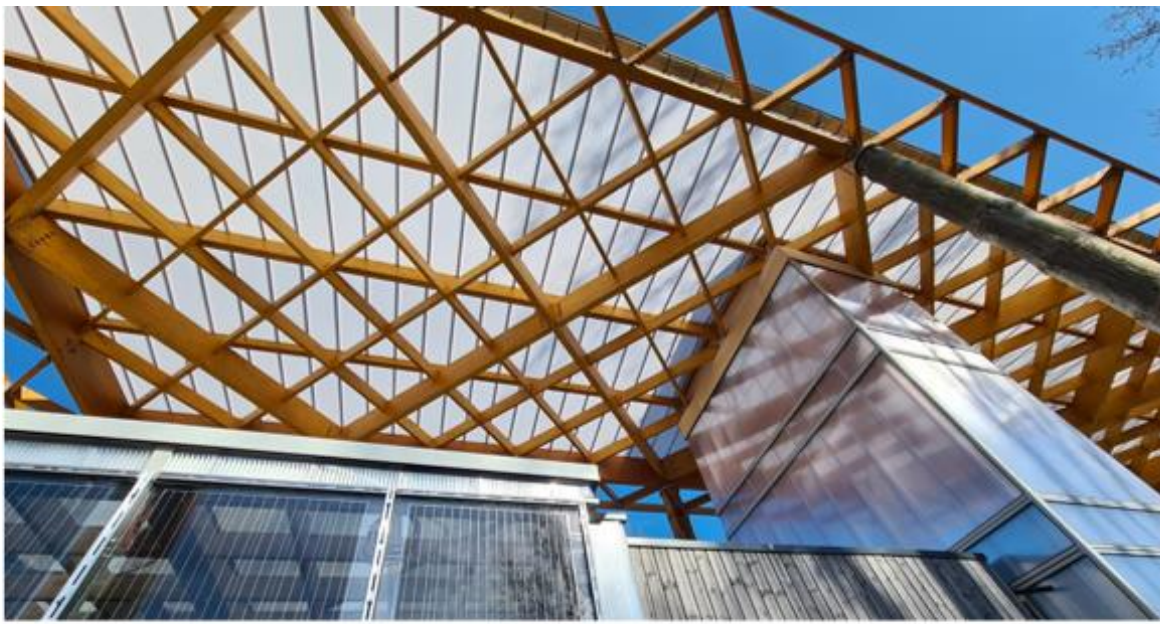
Partly Reversible
Circularity Profile 1
up to 20%
Reuse more than
80% recycling

Partly Reversible
Circularity Profile 2
20 to 40 % Reuse

Reversible Building
Circularity Profile 3
40 to 70% Reuse

Reversible Building
Circularity profile 4
More Than 70%
Reuse
©E. Durmisevic 2019
4D architects









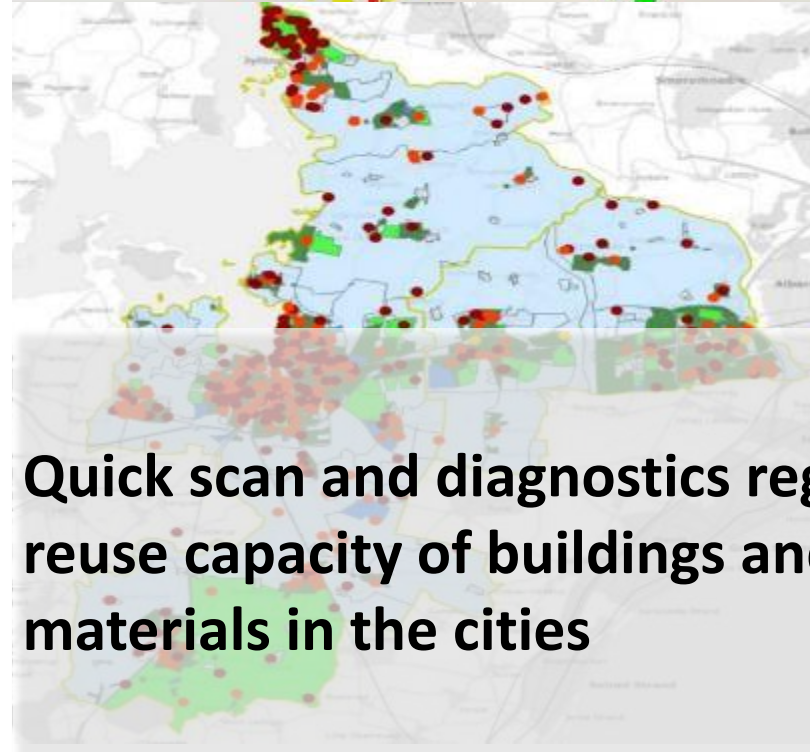
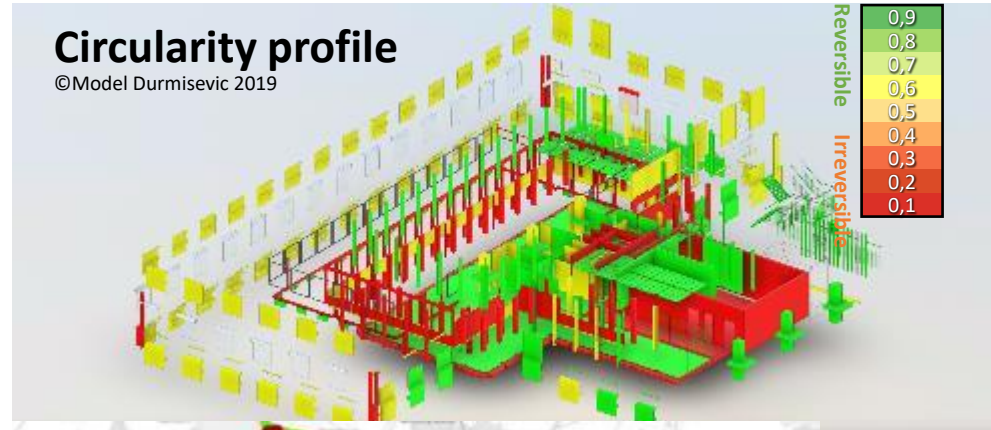
Aim of the LABORATORY FOR GREEN TRANSFORMABLE BUILDINGS

Developing and showcasing circular building solutions



Monitoring, scoring system, inventory

REUSE POTENTIAL

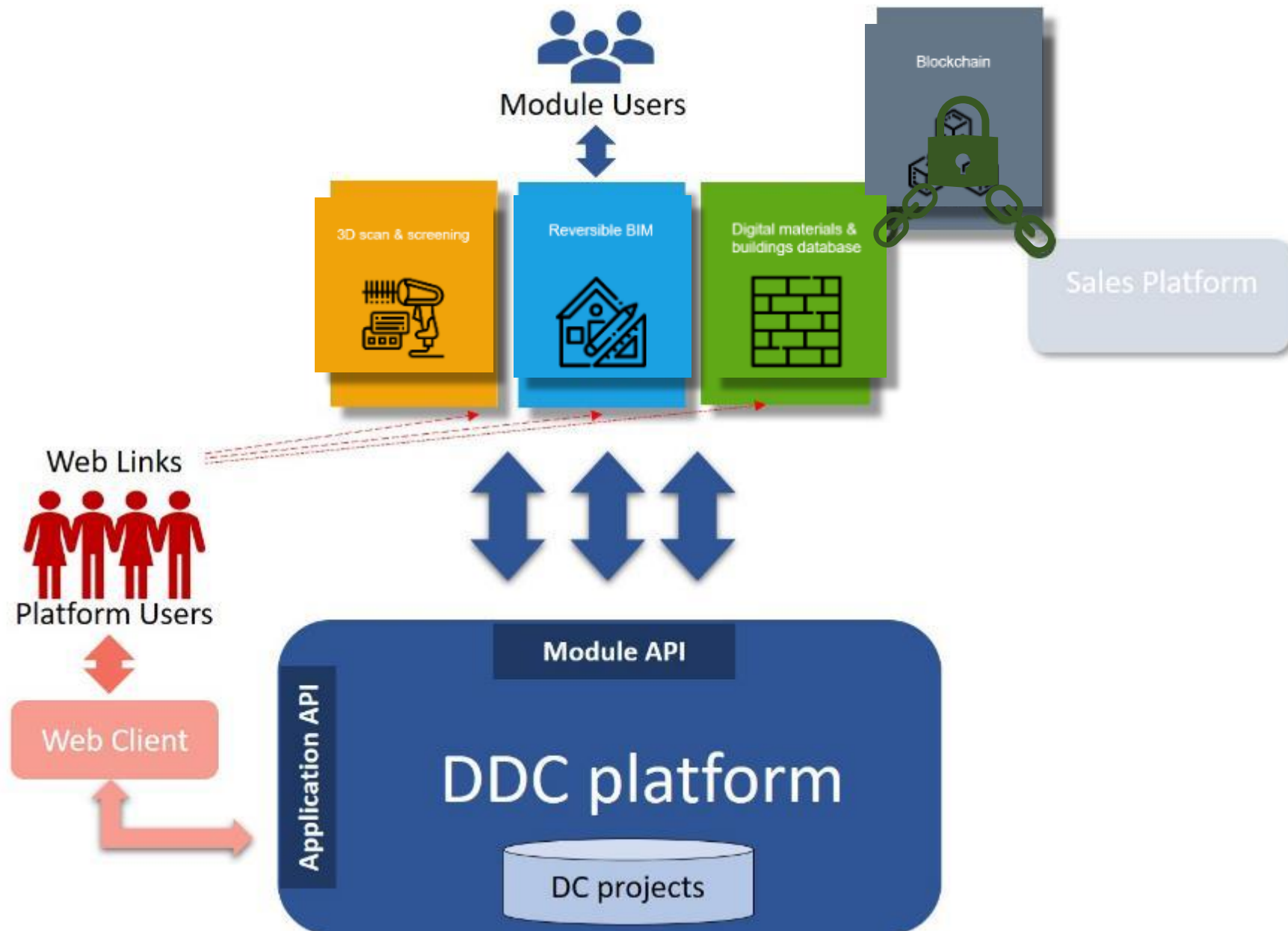


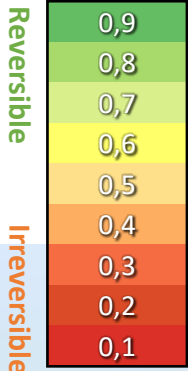
Quick scan and diagnostics regarding reuse capacity of buildings and materials in the cities

DDC

Dr. Elma Durmisevic

25/02/2021

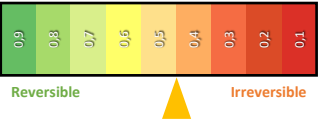




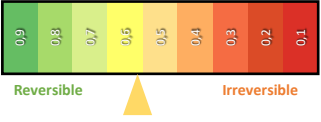
Reversible BIM digital inventory of Reuse Potential

Dr. Elma Durmisevic, 2019

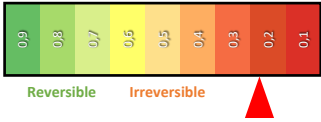
Material substitution/
reuse



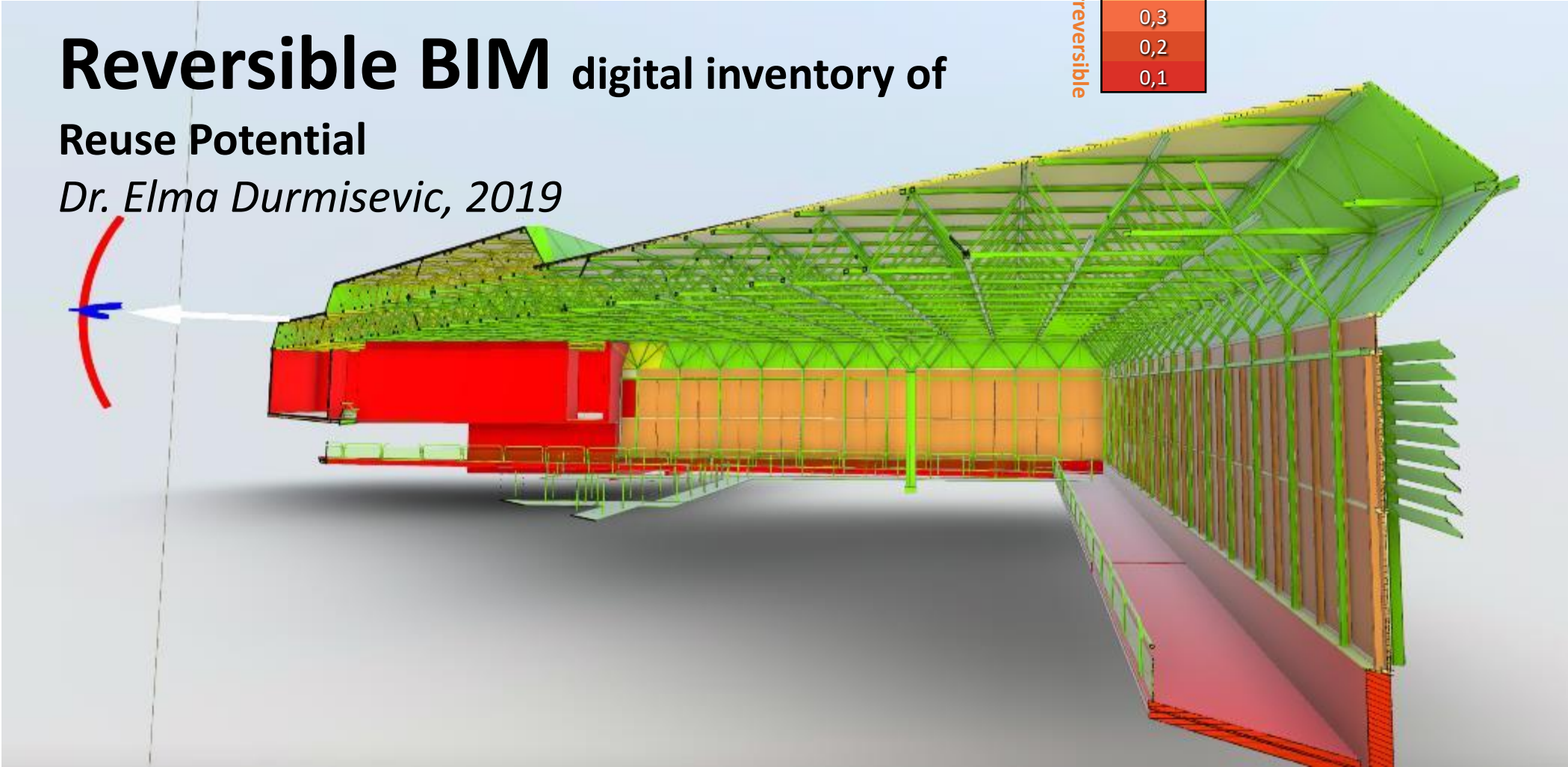
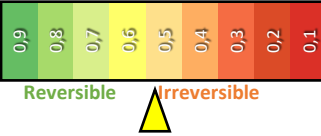
CO2 avoided



Waste produced



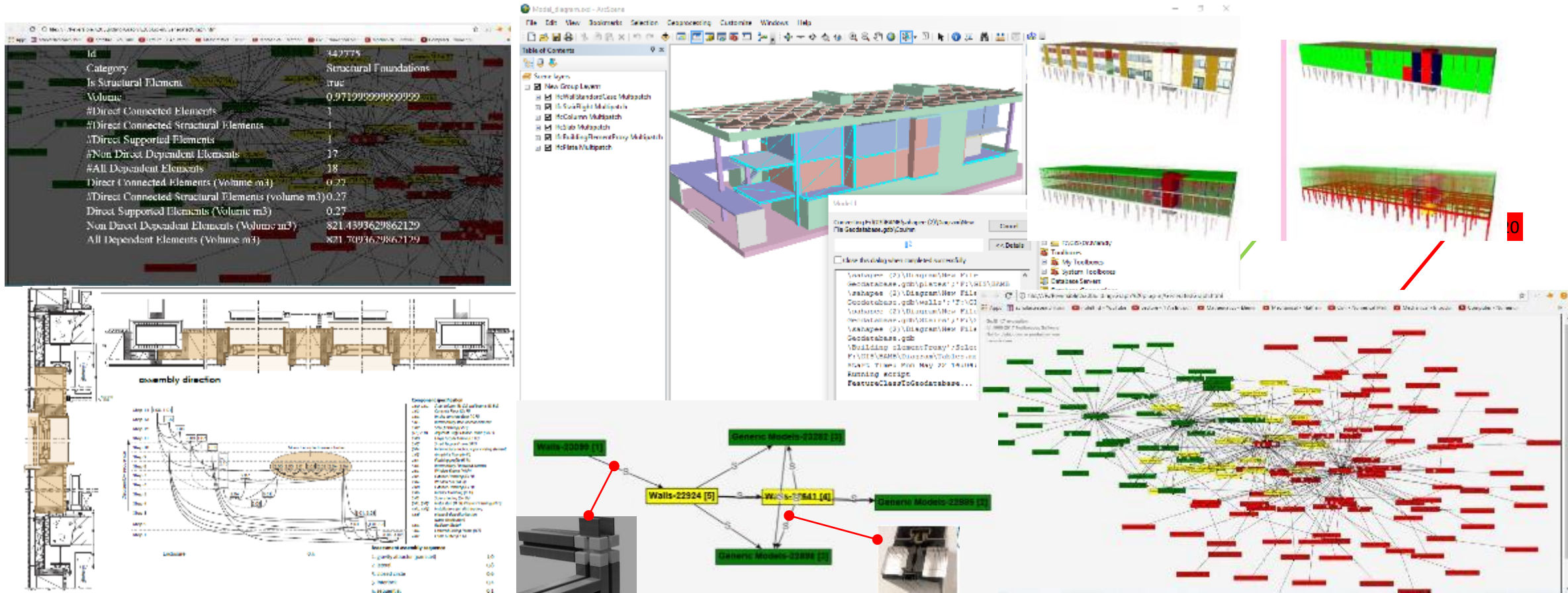
RP/Circularity profile



Reversible
BIM

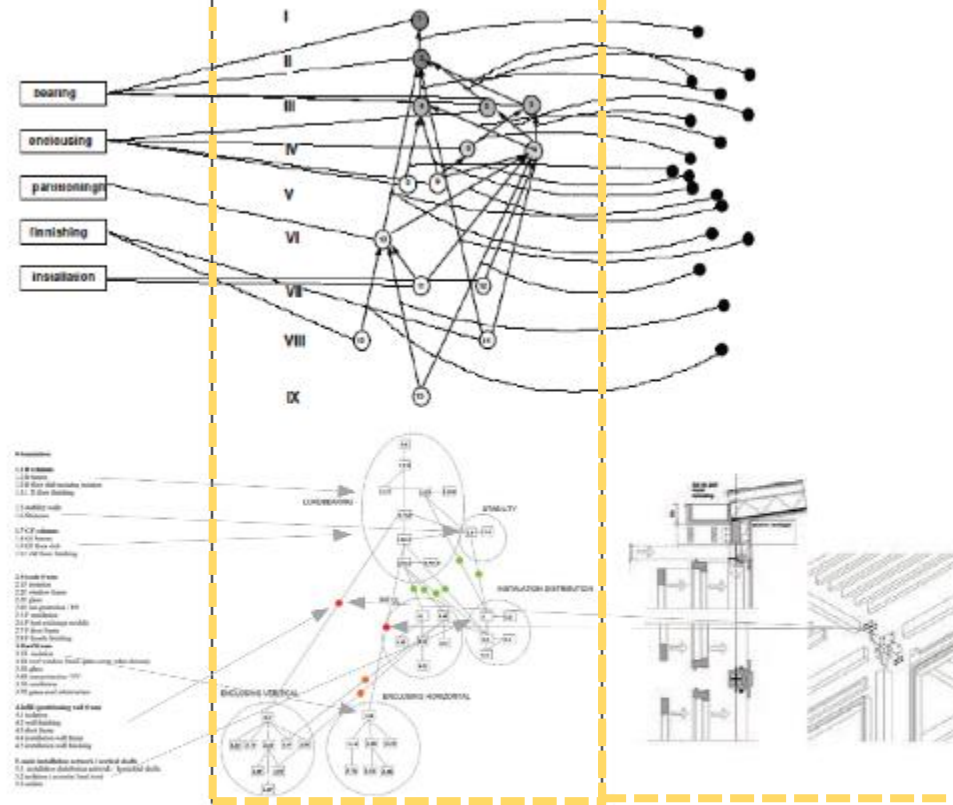
Reuse Potential
Tool

©Model Durmisevic 2018/4D



Reuse Potential Tool

4D architects



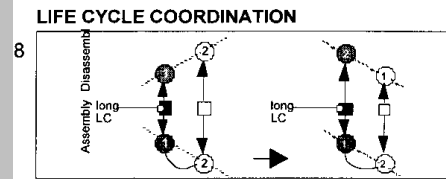
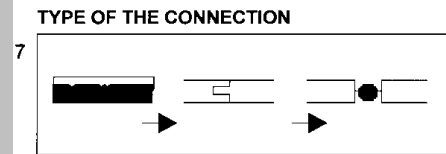
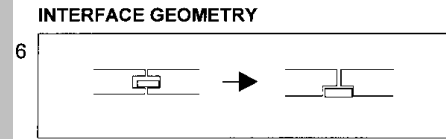
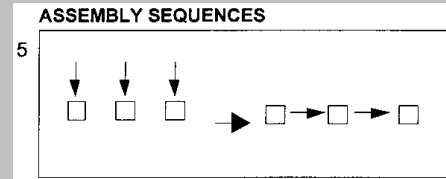
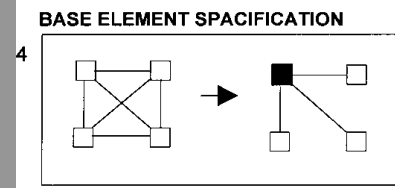
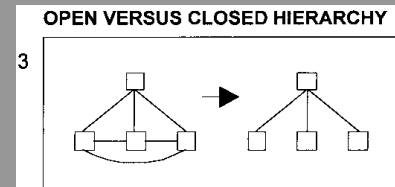
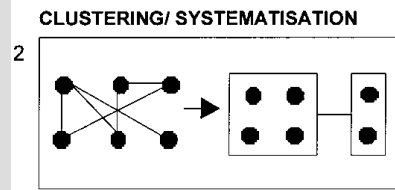
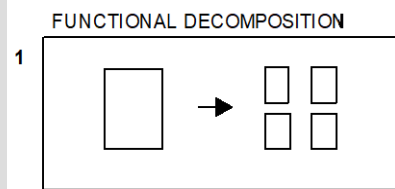
© Durmisevic 2009

INDICATORS/ Technical Reversibility

8 ASPECTS OF TECHNICAL REVERSIBILITY

FUNCTIONAL
decomposition

TECHNICAL
dependences



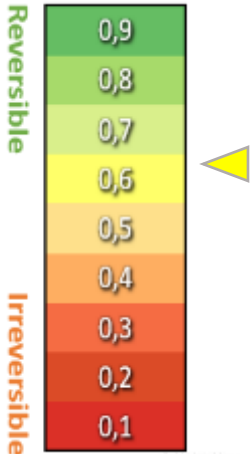
PHYSICAL
dependences

©Model Durmisevic 2015

Reuse potential
= 0,68

Reuse options:

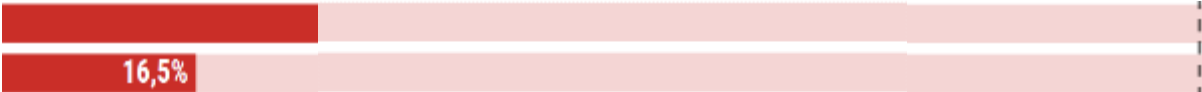
- RP 0,9 = Direct reuse
- RP 0,8 = Direct reuse by minor repair
- RP 0,7 = Reuse by major repair
- RP 0,6 = Reuse by major repair
- RP 0,5 = Re-manufacture
- RP 0,4= Re-manufacture
- RP 0,3 = Mono-material recycle
- RP 0,2 = Recycle
- RP 0,1 = Waste

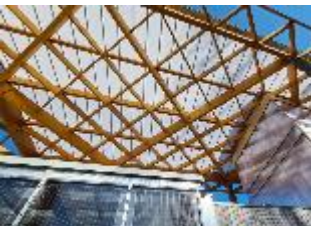


RP Score per sub indicator			RP Score per indicator	
Bottom floor	Top floor	Average both levels	Sub-score	Factors
0,6	0,6	0,60	0,7	1
0,73			0,73	
0,9	0,9	0,90	0,75	2
0,6	0,6	0,60		
0,6	0,9	0,75		
0,9	0,9	0,90	0,82	1
0,8	0,8	0,80		
0,7	0,7	0,70	0,70	1
0,50	0,50	0,50	0,50	1
0,90	0,90	0,90		
0,81	0,79	0,80	0,85	1
0,54	0,51	0,52	0,52	3
0,70	0,69	0,69	0,69	1
0,84	0,84	0,84		
0,80	0,80	0,80	0,82	1
0,78	0,78	0,78	0,78	1
total score*			0,68	

Indicators	
Functional Independence	Functional decomposition
	Systematisation of material levels
Technical Independence	Relational pattern
	Assembly
	Base element
	Life cycle coordination
Physical Independence	Connections
	Accessibility
	Geometry
Dimension	Production Dimension

Embodied Environmental Impact
Embodied Value (EV)





3 CATEGORIES OF MATERIAL STREAMS

in relation to the RP score

IRREVERSIBLE

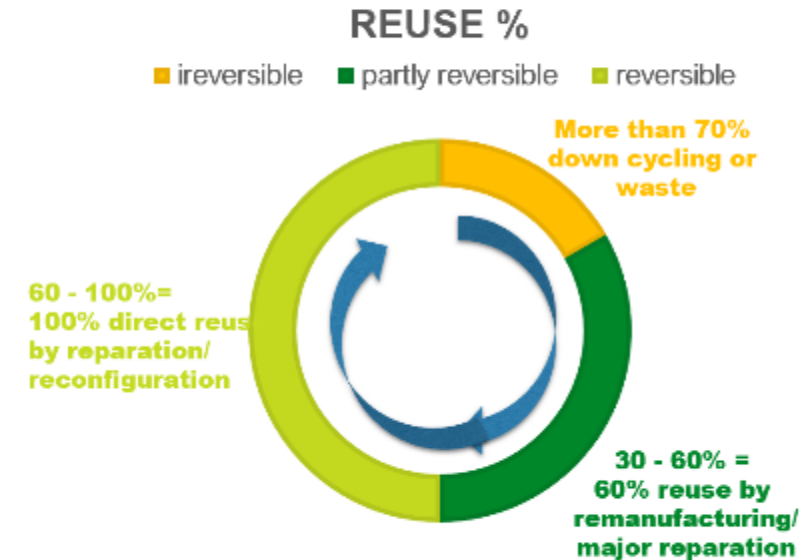
if RP indicates that a system has **RP < than 0,3** these systems will be characterised as irreversible and the end of life options = **RECYCLING/DOWN CYCLING**.

PARTLY REVERSIBLE

If system has **RP > 0,3** and **RP < 0,6** end of life options = **REMANUFACTURE/ MAJOR REPAIR**,

REVERSIBLE

If system has **RP > 0,6** this would mean that besides **DIRECT REUSE AND MINOR REPAIR** of its parts the system can be **RECONFIGURED AND UPGRADED** and its **dimensions adjustable to fit new requirement**.



BUILDING REUSE POTENTIAL

Project name: <Example project>

Location: <city, country>

Function: <office>

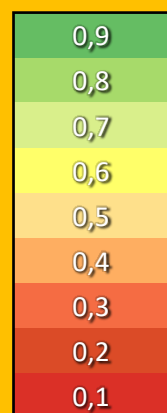
REUSE POTENTIAL/ BUILDING LEVEL

1. Input relational diagram

Relational pattern



Total score RP:



0,5

The Transformation Capacity score measures spatial building performance indicators addressing the capacity to accommodate different functions without causing major reconstruction works, demolition and material loss. The less effort is needed to transform a building, the higher the transformation potential will be. The greater the variety and number of modification options (reuse options of buildings), the higher the transformation potential.



EUROPEAN UNION

4D
architects

Reversible
BIM

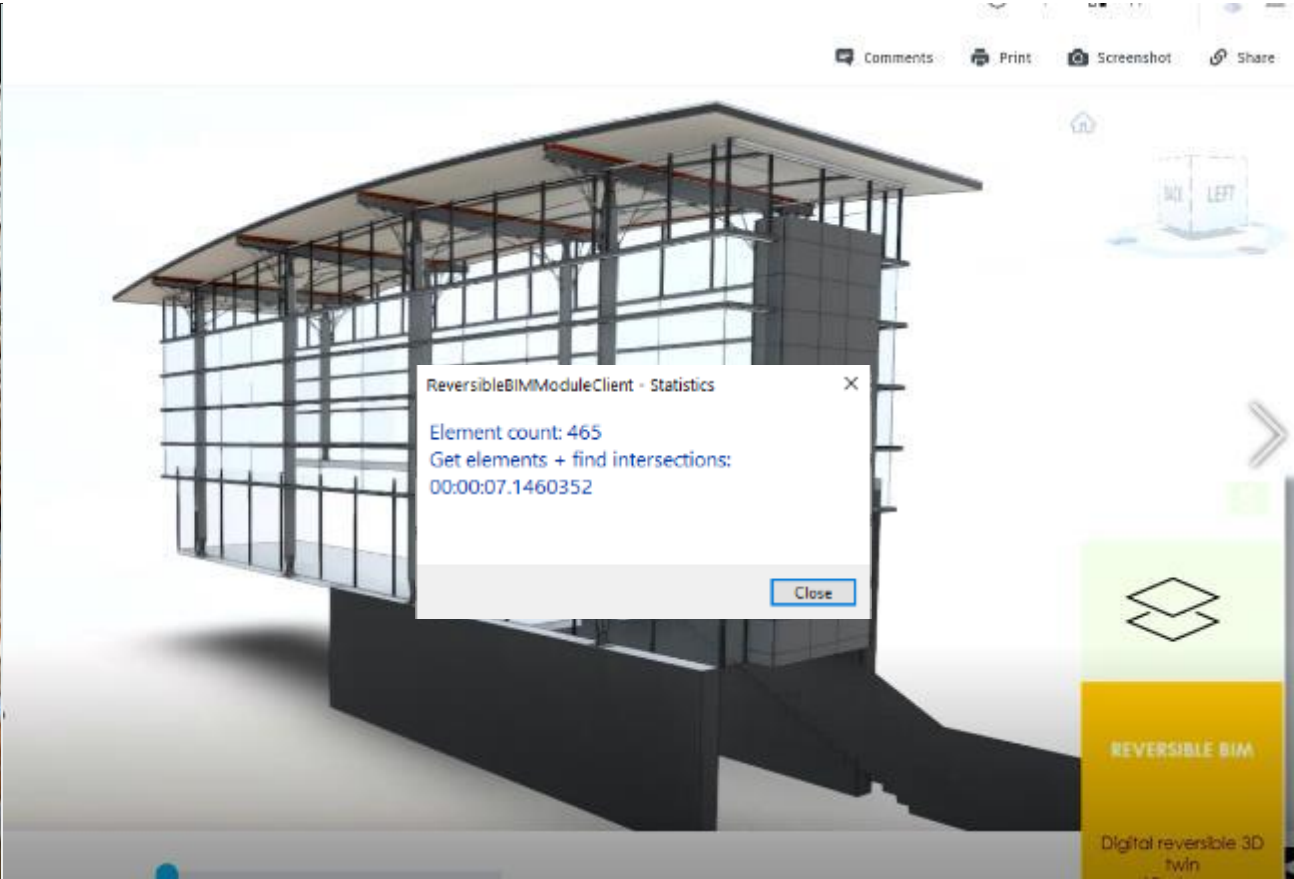
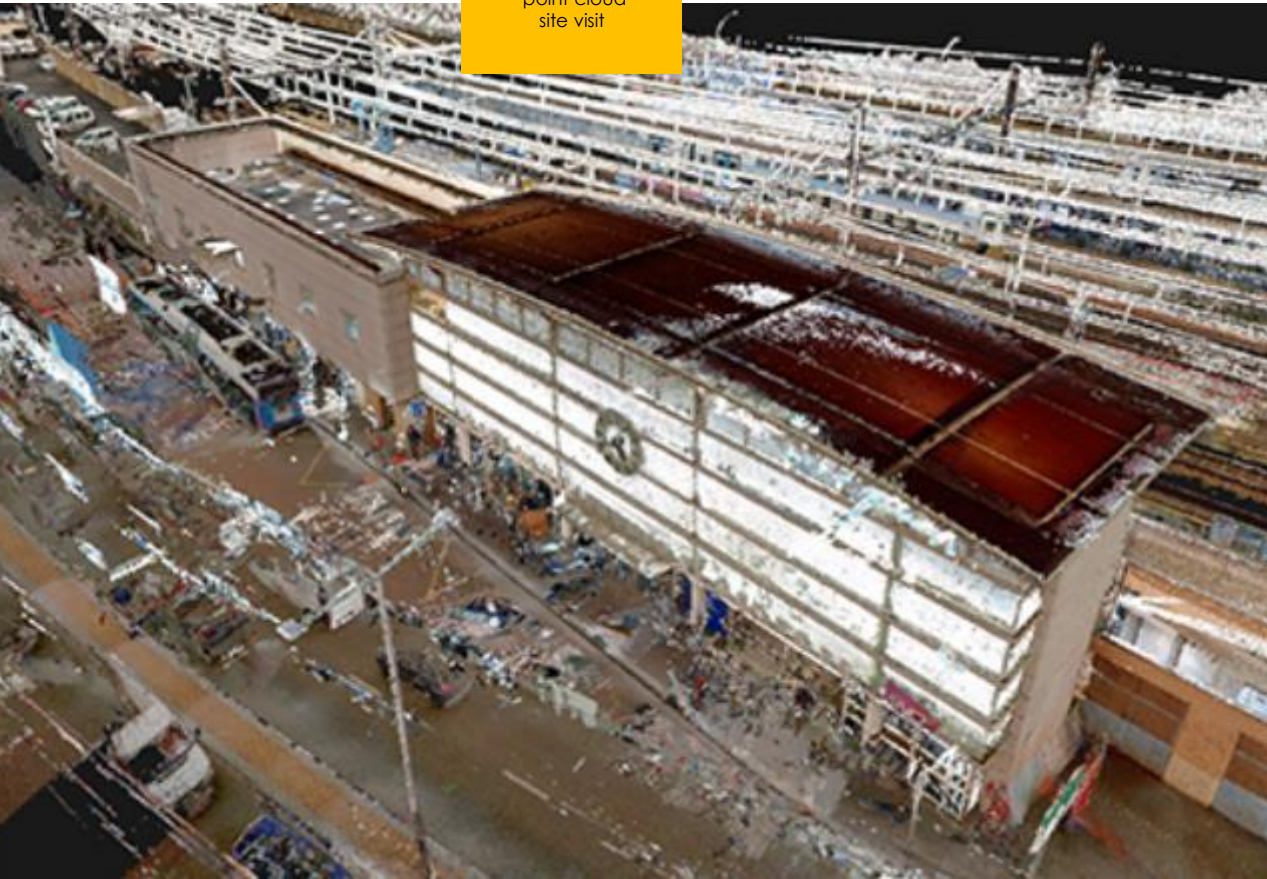
Reuse Potential
Tool

©Model Durmisevic 2015/4D



DATA
GATHERING

Drawings
point cloud
site visit



4D
architects

Colour coded diagram representing relational dependences between elements

BUILDING REUSE POTENTIAL



Element data

Id: 808516

Category: Columns

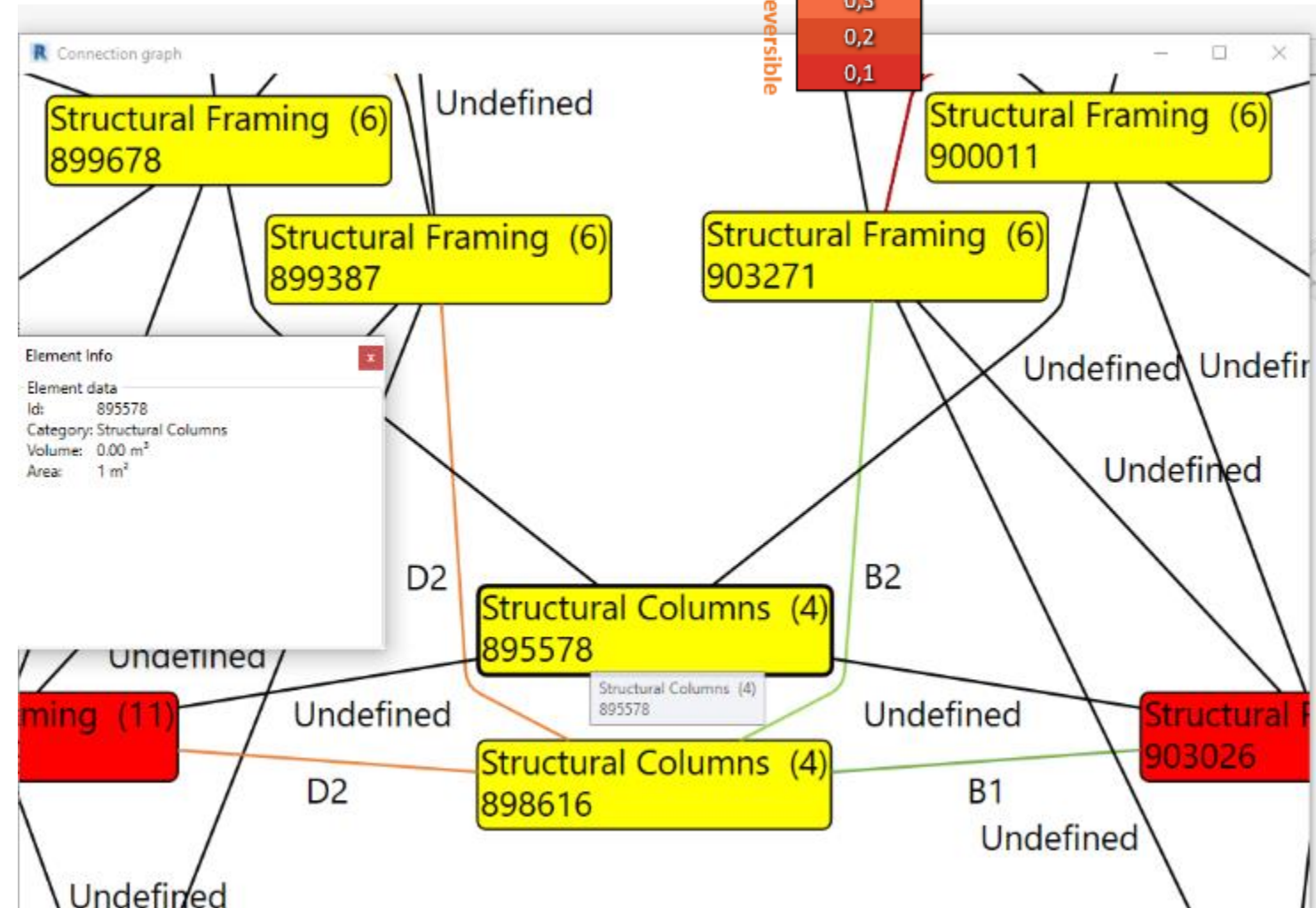
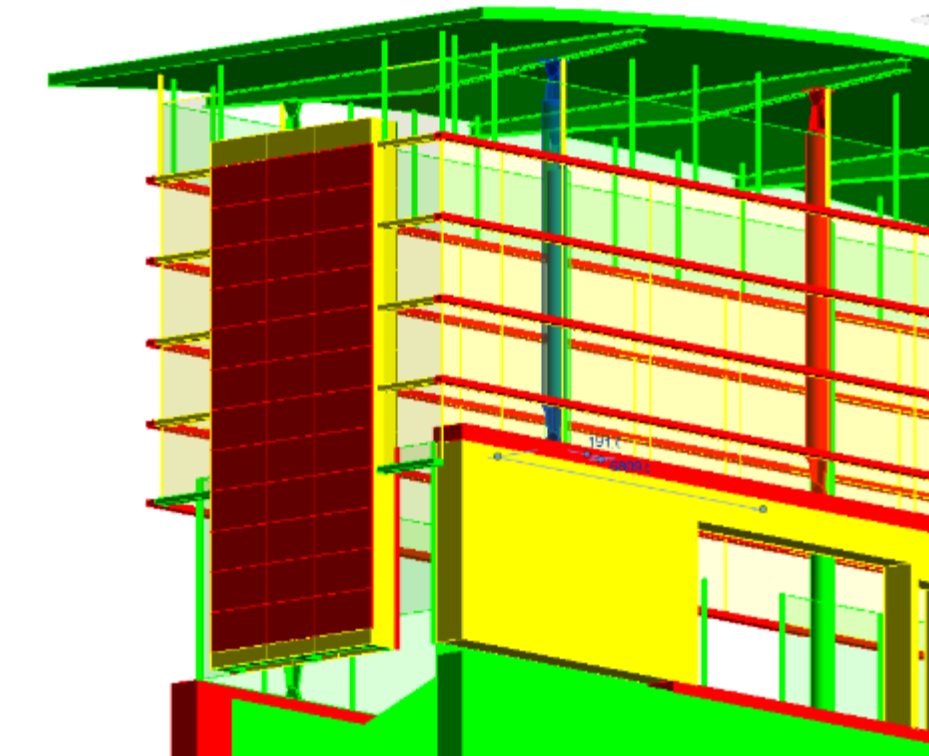
Volume: 0.71 m³

Area: 5 m²

Connections: 4

Element connections

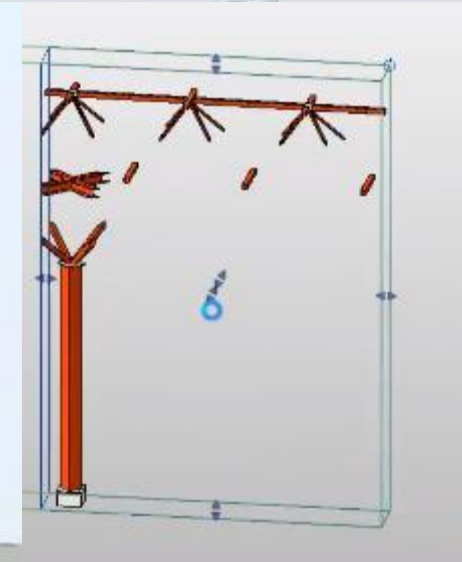
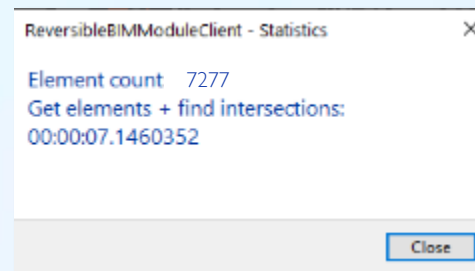
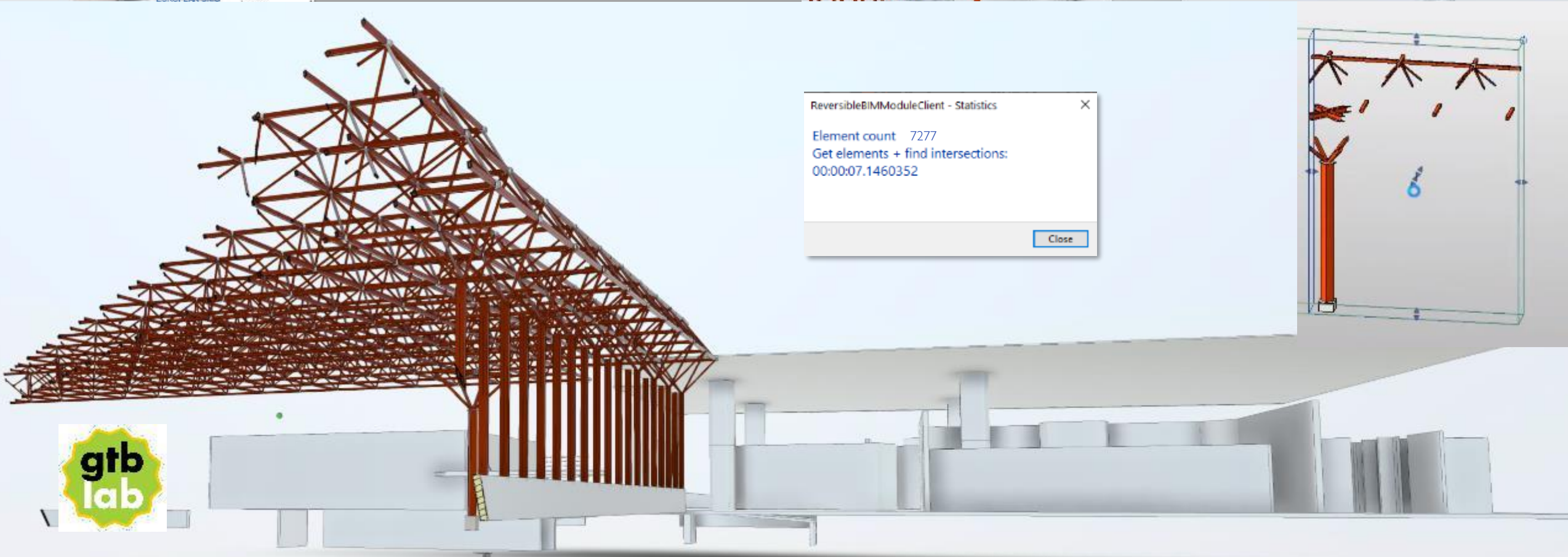
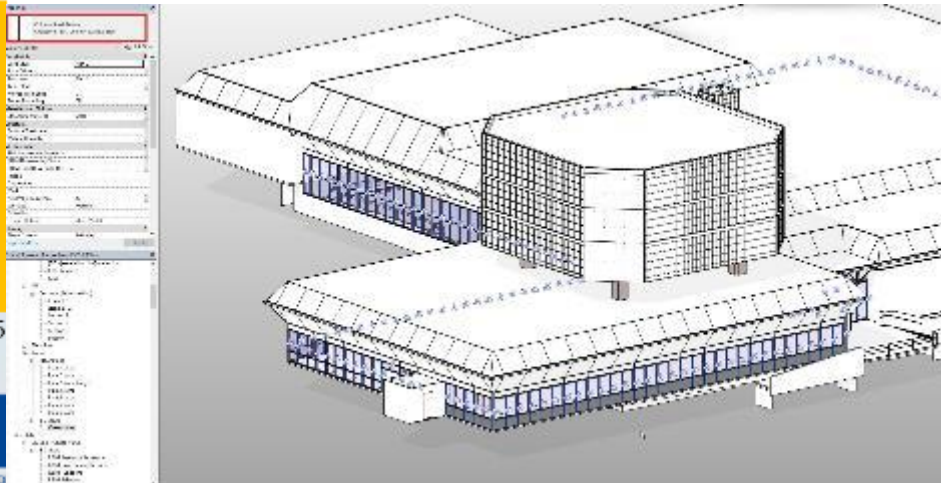
Element ID	Connection type
809146	D1
809387	D2
809026	B1
809271	B2



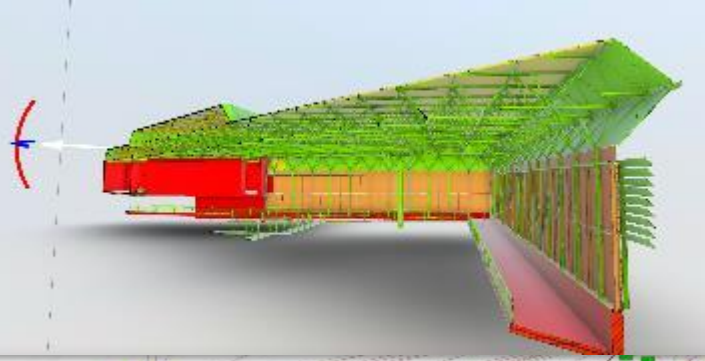
Reversible BIM

Reuse Potential Tool

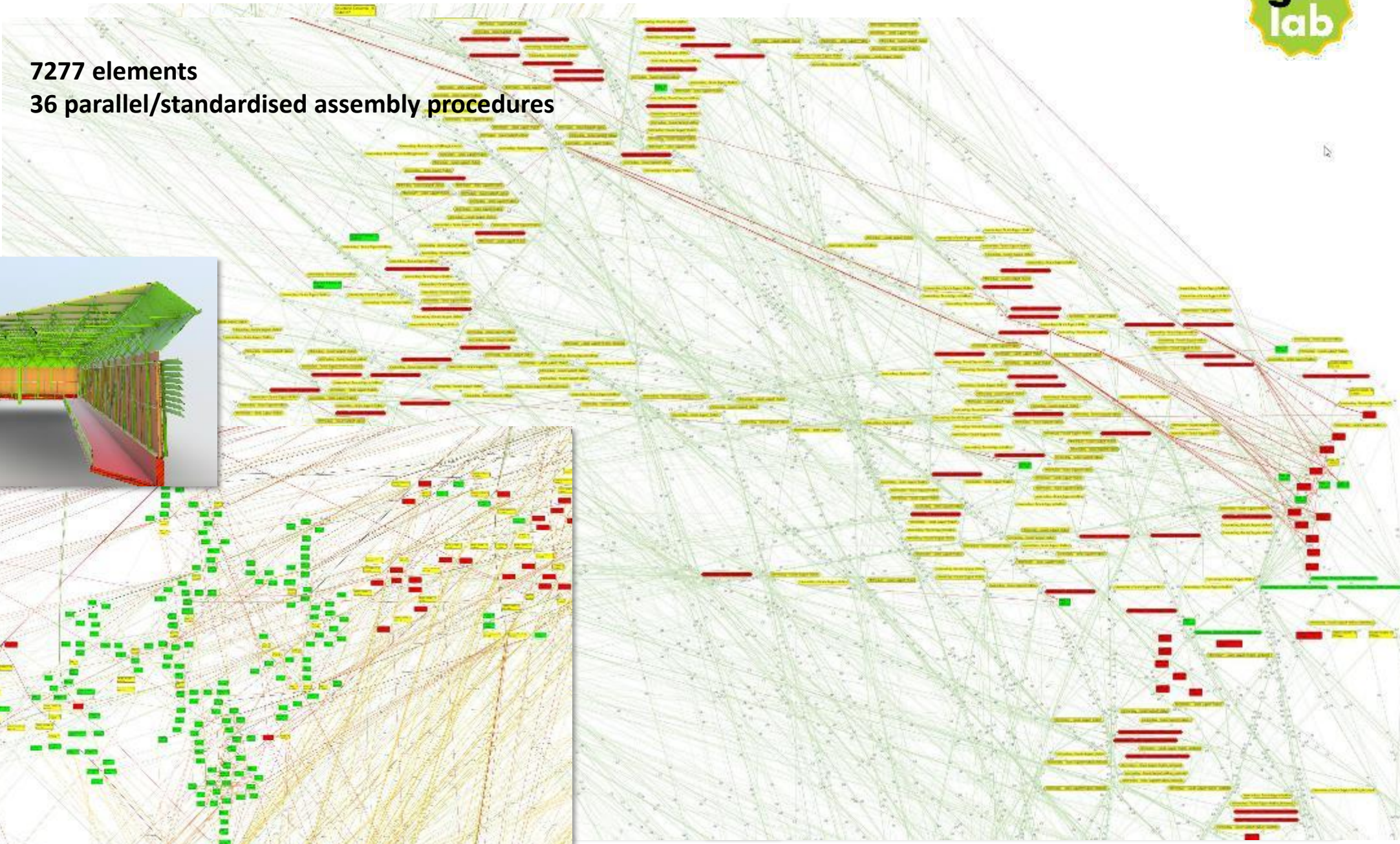
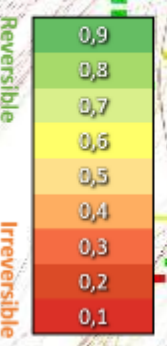
©Model Durmisevic 2015



7277 elements
36 parallel/standardised assembly procedures



BUILDING
REUSE POTENTIAL



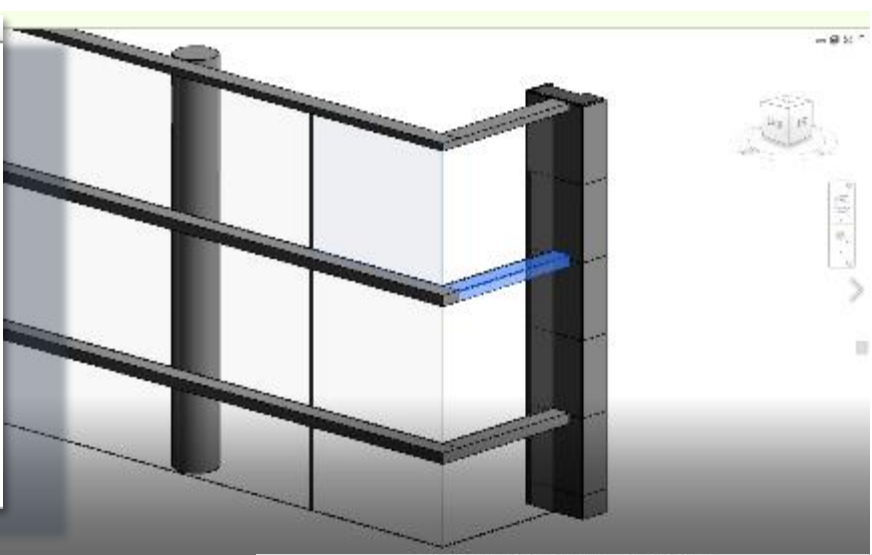
Reversible BIM

Reuse Potential Tool

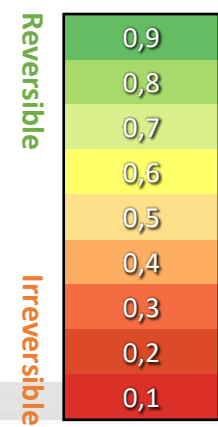
©Model Durmisevic 2015/16

Element connections

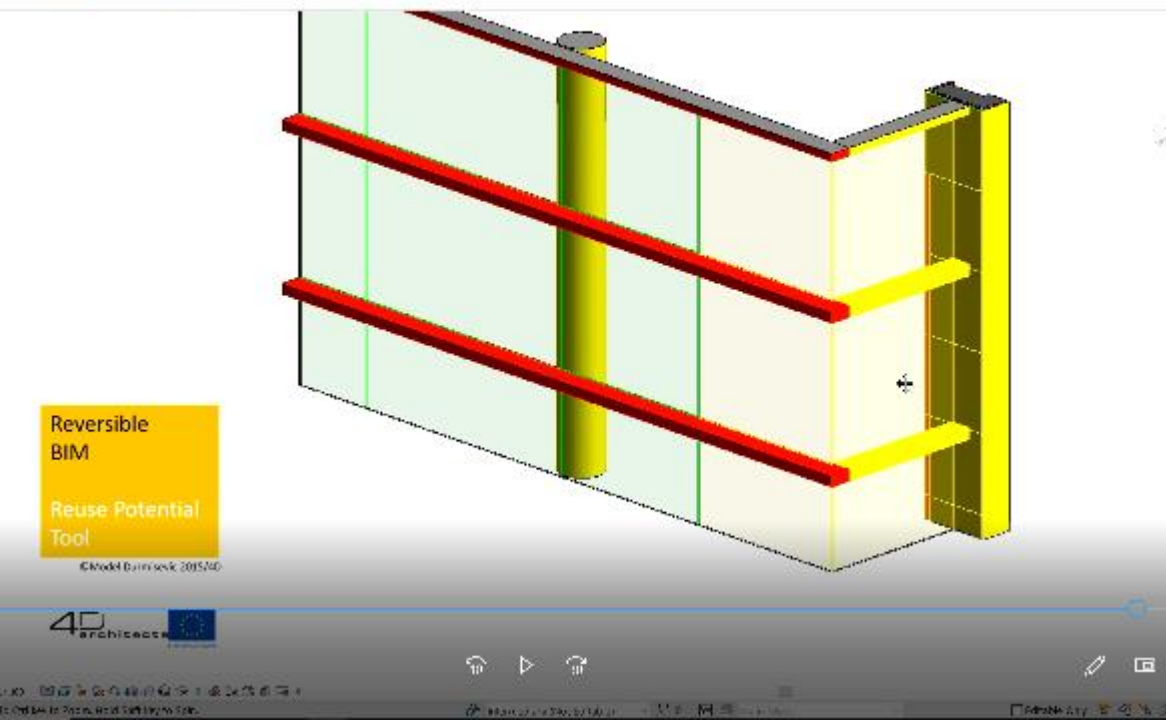
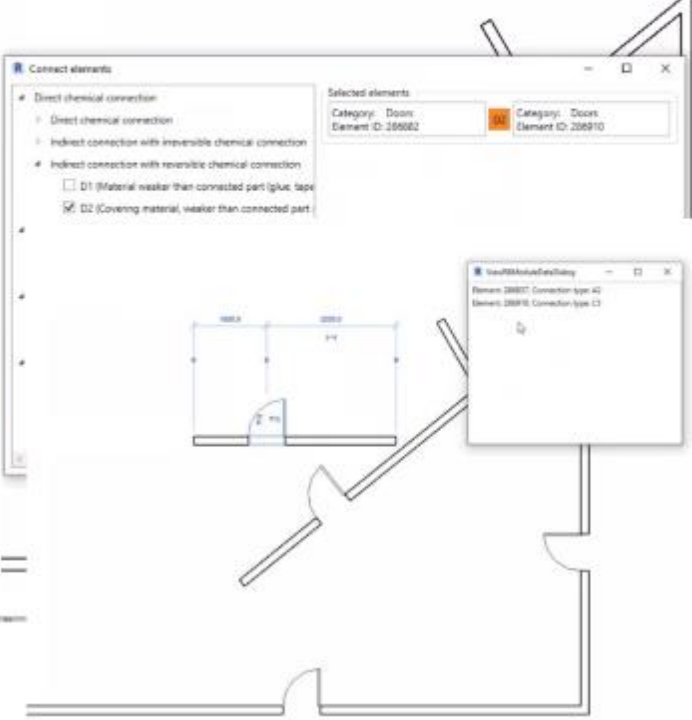
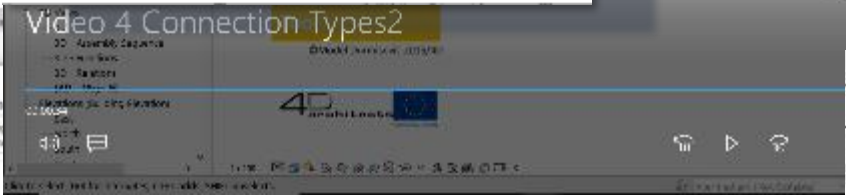
Element data		Element connections	
Id:	898616	Element ID	Connection type
Category:	Columns	891148	D2
Volume:	0.71 m ³	899387	D2
Area:	5 m ²	903026	B1
Connections:	4	903271	B2



BUILDING REUSE POTENTIAL



- Connect elements
- Reversible connections
 - Gravity connection
 - A1 (Gravitational beam connection)
 - Intermediary connection
 - A2 (Indirect Force connection with fastener)
 - Direct connection between two pre-made components
 - B1 (Direct form-lock connection)
 - Direct connections with connecting device
 - Indirect connection via dependent third component
 - B2 (Form-lock connection with fastener)
 - Direct connection with additional fixing device
 - C1 (Direct two access connection (bolt-nut))
 - C2 (One access threaded connection (screw))
 - C3 (One access non-threaded connection (nail, fixation part))
 - Hidden indirect connector
 - Direct insert connection
 - C4 (Hidden dowel connection (dowel connection))
 - C5 (Irreversible one access (nut))
 - Direct chemical connection
 - Indirect connection with reversible chemical connection
 - D1 (Material weaker than connected part (glue, tape))
 - D2 (Covering material, weaker than connected part (plaster, screed))
 - Indirect connection with irreversible chemical connection
 - D3 (Material stronger than connected part (concrete))
 - Direct chemical connection
 - D4 (Covering material, stronger than connected part (plaster, screed))



Reversible BIM

Reuse Potential Tool

©Model Durmisevic 2015

4D
architects

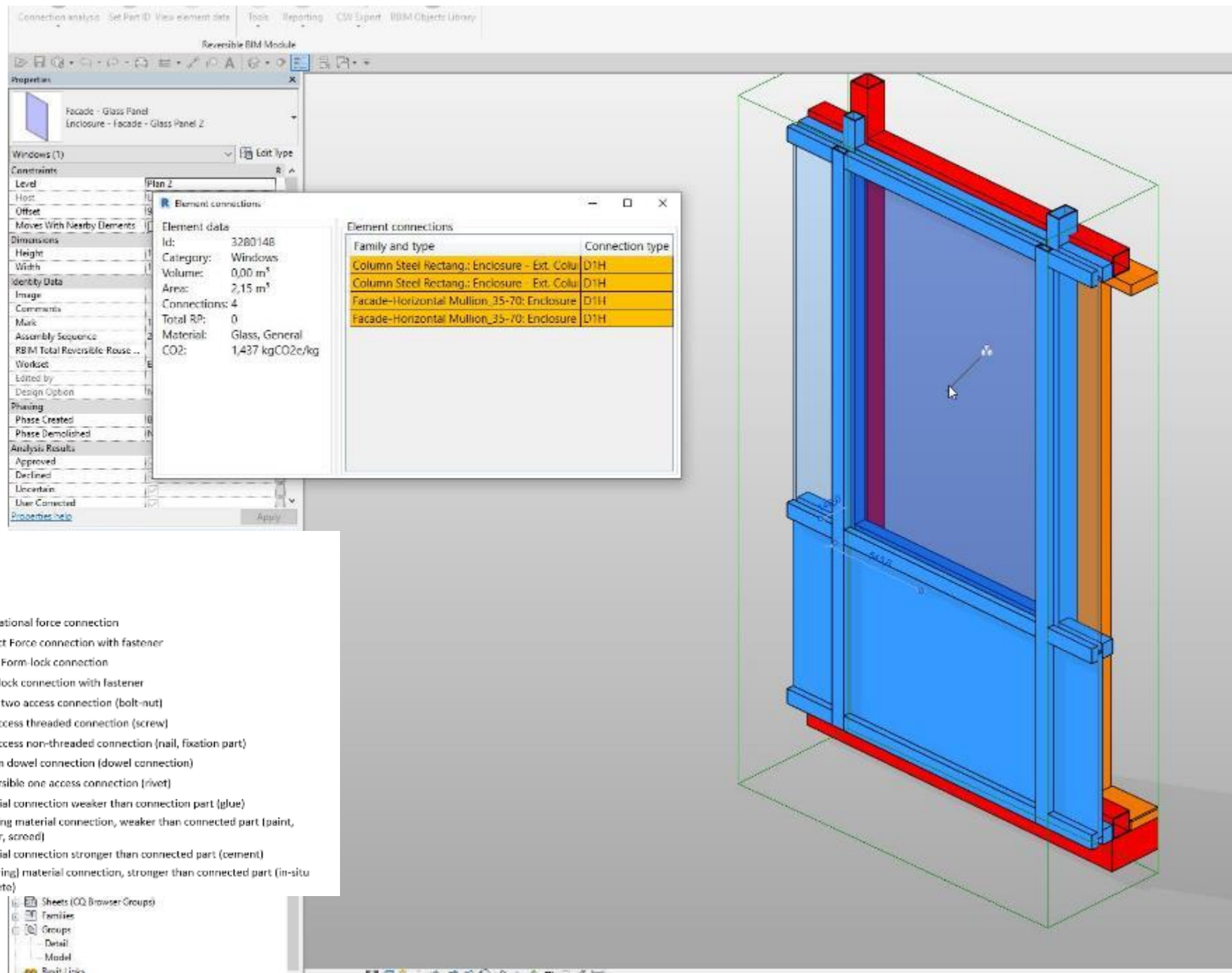


EUROPEAN UNION

INDICATOR 4

RP(c1) type of connection

	Type of Connections	
0,9	A1	Gravitational force connection
0,9	A2	Indirect Force connection with fastener
0,8	B1	Direct Form-lock connection
0,8	B2	Form-lock connection with fastener
0,8	C1	Direct two access connection (bolt-nut)
0,7	C2	One access threaded connection (screw)
0,6	C3	One access non-threaded connection (nail, fixation part)
0,5	C4	Hidden dowel connection (dowel connection)
0,4	C5	Irreversible one access connection (rivet)
0,4	D1	Material connection weaker than connection part (glue)
0,3	D2	Covering material connection, weaker than connected part (paint, plaster, screed)
0,1	D3	Material connection stronger than connected part (cement)
0,1	D4	(Covering) material connection, stronger than connected part (in-situ concrete)



Reversible BIM

Reuse Potential Tool

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Glass Facade [28360...

Glass Facade [28564...

Glass Facade [28581...

Glass Facade [28667...

► Profile Facade

► Panel Vent.Facade

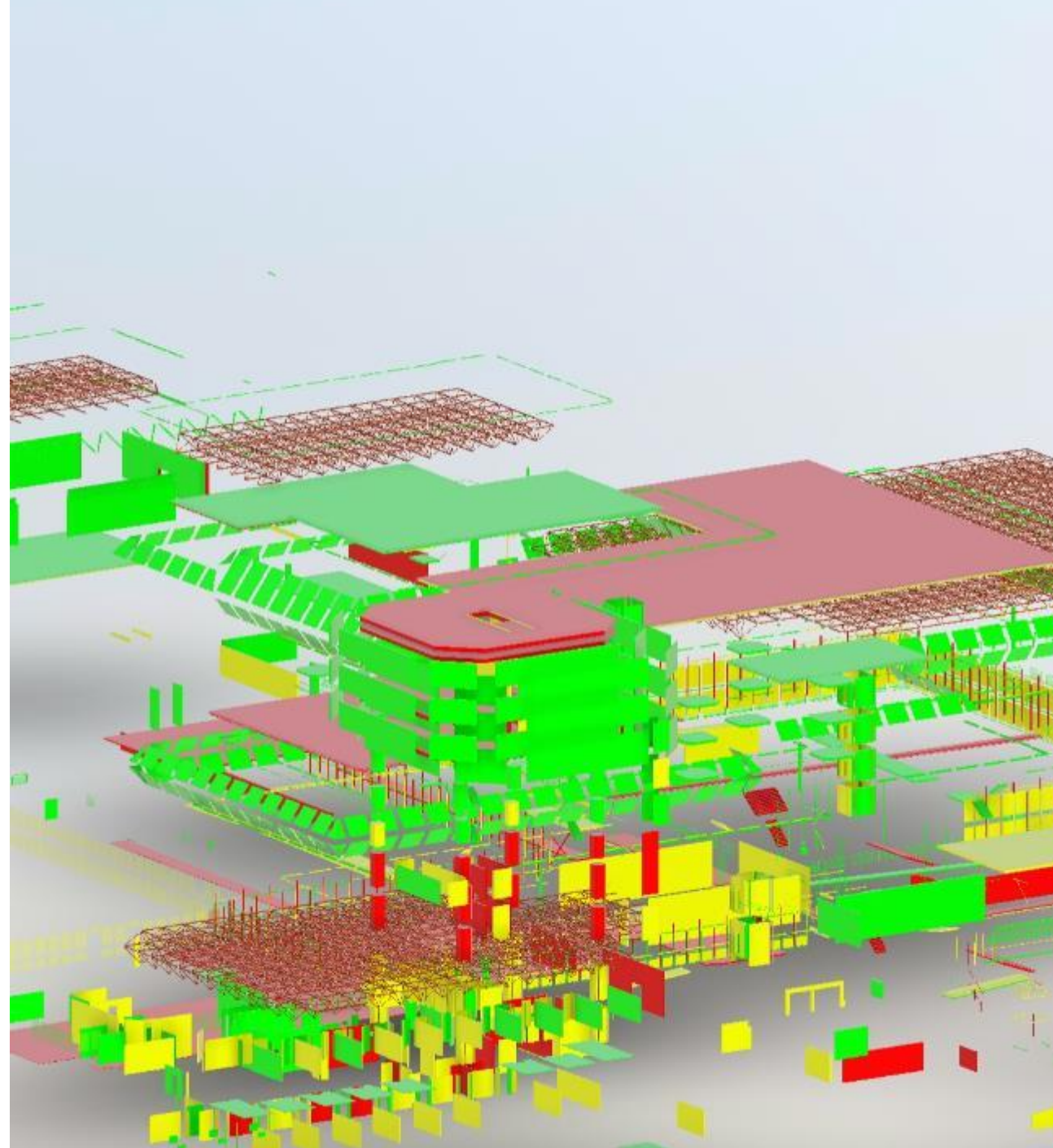
▼ Floors

▼ Floor

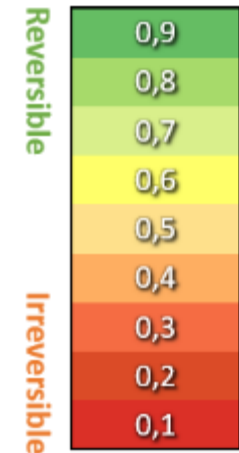
▼ Floor Slab 200 mm

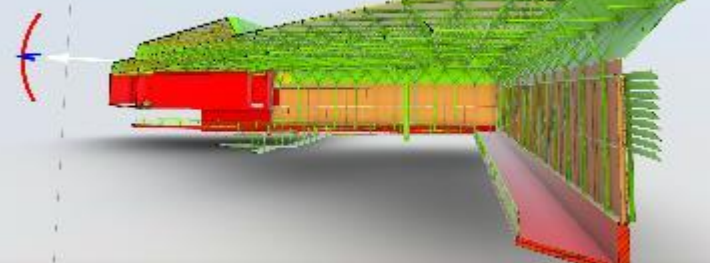
Floor [280579]

► Roofs



BUILDING REUSE POTENTIAL



Information for inventory
expert

Element sheet

total ton embodied CO2 = 6070 ton CO2

Avoided CO2 = 5202 ton CO2 total reused material = 567 m3

4D
architects

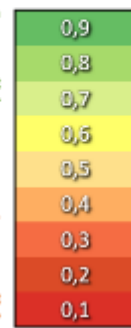
	Revit data export										making data suitable						
	Sequence no.	ID	Type	level	Element function	Material name	Embodied car.	Volume	Area	Number	Total RP	Reused carbon(kg)	Reused material (m3)	function	Material group	material (ton)	Reused material (ton)
7230	35	3277732	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	28,60431336	0,182495	12,16635	2	0,75	12,87191092	0,082122885	3. Partitioning	Plaster	0,330242008	0,139608904
7231	35	2133406	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	15,23674247	0,09721	5,980687	3	0,75	6,056531111	0,041365439	3. Partitioning	Plaster	0,166257511	0,071365439
7232	35	2133406	Finish - IV Wall 15 Tiles Ceramic	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	39,11559335	0,03382	2,08039	1	0,75	17,36001701	0,01611906	3. Partitioning	Ceramics	0,050148197	0,027566688
7233	35	2144659	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	16,26394903	0,118639	7,75928	4	0,75	8,22889366	0,05748518	3. Partitioning	Plaster	0,188278277	0,089278277
7234	35	2172061	Finish - IV Wall 15 Tiles Ceramic	Plan 3	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	14,56497334	0,01137	0,936427	1	0,75	8,56570633	0,00599808	3. Partitioning	Ceramics	0,018647407	0,008191131
7235	35	2144658	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	6,145435075	0,040484	2,719177	4	0,75	2,855445784	0,018217772	3. Partitioning	Plaster	0,068827508	0,030970128
7236	35	2131814	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	5,670187168	0,036176	2,411717	5	0,75	2,551584226	0,016279088	3. Partitioning	Plaster	0,061498776	0,027674440
7237	35	2131723	Finish - IV Wall 15 Tiles Ceramic	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	26,80048869	0,024543	1,636171	3	0,75	12,06021091	0,010444157	3. Partitioning	Ceramics	0,034359601	0,01546182
7238	35	2131902	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	4,387454736	0,027992	1,866129	4	0,75	1,974354631	0,012596367	3. Partitioning	Plaster	0,047586277	0,021413825
7239	35	2131922	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	6,720716482	0,042878	2,858541	5	0,75	3,024322417	0,010295154	3. Partitioning	Plaster	0,072892803	0,032801762
7240	35	2131626	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	15,03713408	0,095037	6,395787	4	0,75	6,766710335	0,04317150	3. Partitioning	Plaster	0,103092561	0,073391652
7241	35	2144661	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	4,71772926	0,090099	2,046651	4	0,75	2,122978167	0,013544584	3. Partitioning	Plaster	0,05110848	0,023023794
7242	35	2131582	Finish - IV Wall 15 Tiles Ceramic	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	73,17831505	0,067013	4,67541	3	0,75	32,93024206	0,030155895	3. Partitioning	Ceramics	0,093818353	0,042218259
7243	35	2144662	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	6,585035686	0,042012	2,810878	5	0,75	2,963266059	0,018935612	3. Partitioning	Plaster	0,071421211	0,032139542
7244	35	3277733	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	28,60431336	0,182495	12,16635	2	0,75	12,87191092	0,082122885	3. Partitioning	Plaster	0,330242008	0,139608904
7245	35	2130270	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	13,32662238	0,085024	5,36825	4	0,75	5,996800359	0,038236088	3. Partitioning	Plaster	0,144570375	0,065031168
7246	35	2144660	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	12,9941745	0,074746	5,136663	1	0,75	5,624713651	0,03885749	3. Partitioning	Plaster	0,135588519	0,061005034
7247	35	2131263	Finish - IV Wall 15 Tiles Ceramic	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	39,65714516	0,0316107	2,420155	1	0,75	17,8098532	0,016132843	3. Partitioning	Ceramics	0,040323363	0,020103066
7248	35	2131197	Finish - IV Wall 15 Mortar Cement	Plan 2	Finishing	Plaster, Dried clay plaster	6,291456786	0,057894	3,528629	4	0,75	3,73155129	0,023804742	3. Partitioning	Plaster	0,08942627	0,040488026
7249	35	2131131	Finish - IV Wall 15 Tiles Ceramic	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	39,50871489	0,036818	2,417609	3	0,75	17,7789717	0,016281064	3. Partitioning	Ceramics	0,050657199	0,027793485
7250	35	2131018	Finish - IV Wall 15 Tiles Ceramic	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	38,80864485	0,035827	2,374777	3	0,75	17,50448016	0,016070744	3. Partitioning	Ceramics	0,049870314	0,027447641
7251	36	4267324	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	244,0267757	0,785022	15,70643	1	0,0	220,4340081	0,706519648	3. Partitioning	Plaster	0,628017373	0,565215638
7252	36	8100477	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	123,5005767	0,395835	7,916704	1	0,0	111,150619	0,356251664	3. Partitioning	Plaster	0,31668145	0,285001331
7253	36	8200234	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	228,1772335	0,731337	14,62675	1	0,0	205,3595101	0,658203558	3. Partitioning	Plaster	0,585062829	0,526562846
7254	36	8200470	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	178,7982893	0,573071	11,46143	1	0,0	160,0184004	0,515764294	3. Partitioning	Plaster	0,458457152	0,412611437
7255	36	4268940	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	244,0267757	0,785114	15,70228	1	0,0	220,4073366	0,706620079	3. Partitioning	Plaster	0,628112007	0,565300863
7256	36	4268998	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,7242212	0,781168	15,62336	1	0,0	219,351979	0,703051212	3. Partitioning	Plaster	0,624934413	0,562440972
7257	36	2150136	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	82,77593338	0,265307	5,30615	1	0,0	74,68831001	0,232776731	3. Partitioning	Plaster	0,212245983	0,191021382
7258	36	4268620	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,1810131	0,780388	15,60776	1	0,0	219,1329391	0,702349167	3. Partitioning	Plaster	0,624310368	0,561879333
7259	36	8221174	Partition - Ceiling Plywood Multiplex Wood 20	Plan 2	Partitioning	Timber, Particle Board	-33,79778145	0,0598041	2,992051	1	0,0	-30,178006	0,06385682	3. Partitioning	Timber	0,011100576	0,006991414
7260	36	8194955	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	285,3403889	0,814553	18,29105	1	0,0	256,8063509	0,731087274	3. Partitioning	Plaster	0,731087274	0,658477421
7261	36	8135584	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	62,97161674	0,268425	5,178695	1	0,0	44,8447257	0,234161259	3. Partitioning	Plaster	0,234161259	0,191470034
7262	36	8135471	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	100,6768940	0,327849	6,51898	1	0,0	90,1520812	0,28868417	3. Partitioning	Plaster	0,254742974	0,211773798
7263	36	8376201	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	981,4187064	3,087881	61,75767	1	0,0	867,0769168	2,778097687	3. Partitioning	Plaster	2,470334608	2,223274148
7264	36	8376090	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	1353,1543526	4,317674	86,75348	1	0,0	1211,821893	3,930905708	3. Partitioning	Plaster	3,470136798	3,121125367
7265	36	4266273	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,7861804	0,774802	15,49783	1	0,0	217,5895642	0,697402444	3. Partitioning	Plaster	0,619913288	0,557921950
7266	36	4435363	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	397,7691032	1,274001	25,42802	1	0,0	357,2921029	1,147410875	3. Partitioning	Plaster	1,019202777	0,9179282
7267	36	2112436	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	336,4103531	1,078238	21,56477	1	0,0	302,7693178	0,97041448	3. Partitioning	Plaster	0,862590649	0,776331584
7268	36	2118883	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,4849586	0,780401	15,60801	1	0,0	219,1364628	0,702360458	3. Partitioning	Plaster	0,624320407	0,561888366
7269	36	8376482	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	73,0322585	0,234078	4,681555	1	0,0	65,72903265	0,210609070	3. Partitioning	Plaster	0,187262201	0,168530981
7270	36	8376900	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	13,96318722	0,044754	0,895070	1	0,0	12,5668685	0,024278422	3. Partitioning	Plaster	0,035803044	0,03222274
7271	36	8376857	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	73,11648333	0,234348	4,680951	1	0,0	65,804835	0,210912933	3. Partitioning	Plaster	0,187478162	0,168730940
7272	36	8222806	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	233,8518278	0,743115	14,8623	1	0,0	208,666645	0,688893369	3. Partitioning	Plaster	0,594193865	0,535041268
7273	36	8376943	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	20,76059594	0,065082	1,311383	1	0,0	18,43813815	0,052473328	3. Partitioning	Plaster	0,052473328	0,047225995
7274	36	8376696	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	14,30657054	0,045857	0,917088	1	0,0	12,87591385	0,015268952	3. Partitioning	Plaster	0,03660515	0,030015164
7275	36	8376621	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	21,19408480	0,067917	1,186336	1	0,0	19,01108289	0,061725019	3. Partitioning	Plaster	0,054133513	0,048900761
7276	36	8376814	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	27,85172039	0,212866	4,85729	1	0,0	25,38814095	0,087892018	3. Partitioning	Plaster	0,18629159	0,167674717
7277	36	8376752	Partition - Ceiling Generic 50 mm Gypsum	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	38,36762973	0,099636	5,43623	1	0,0	35,42212715	0,084813261	3. Partitioning	Plaster	0,07247861	0,065185562

Reversible

0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1

Irreversible

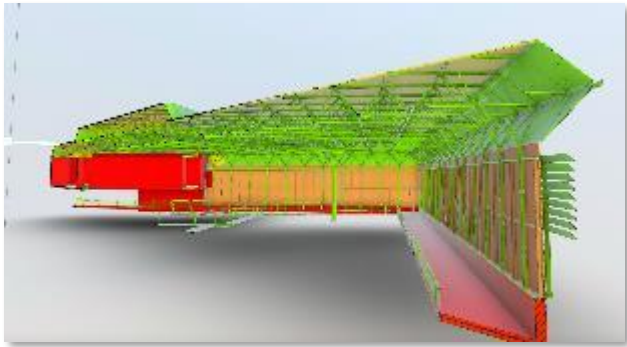
BUILDING
REUSE POT

BUILDING
REUSE POTReversible
Irreversible

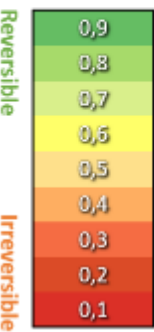
Reversible
BIM

Reuse Potential
Tool

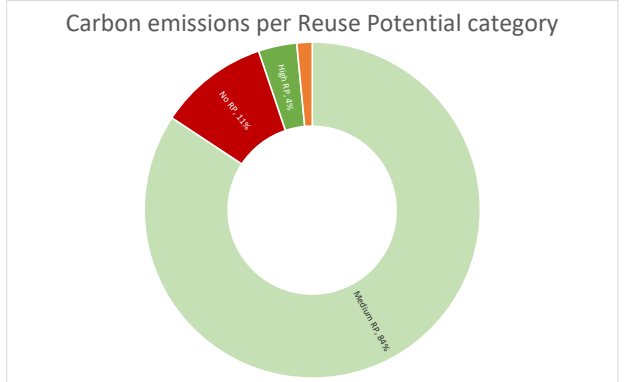
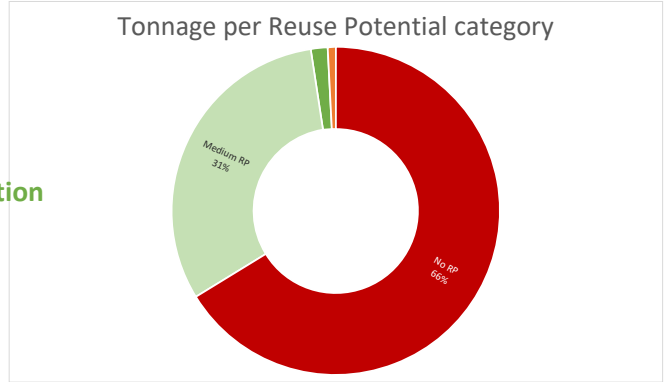
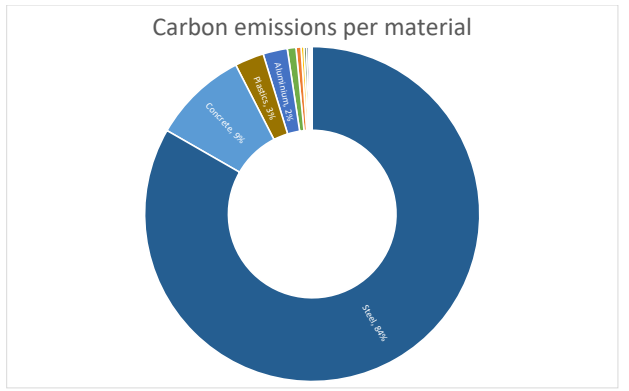
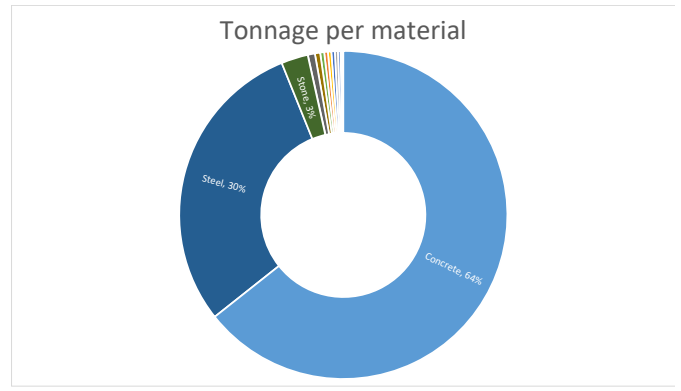
©Model Durmisevic 2015



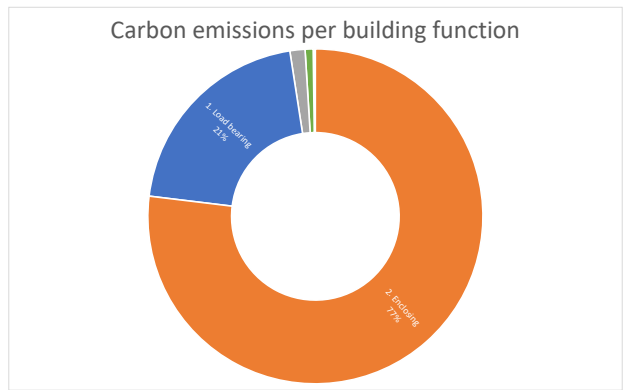
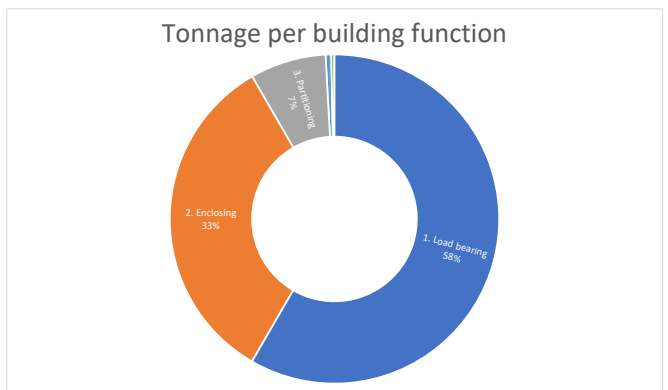
BUILDING
REUSE POTENTIAL



Information for owner/cost benefits
analyses & policy makes & inventory expert



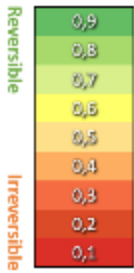
Avoided CO2 ton
3000 ton



Information for owner/cost
benefits analyses & policy
makes & inventory expert

Tonnages and reuse options

BUILDING REUSE POTENTIAL

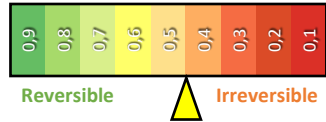


Ci(R) 08 -09: Direct Re-use or minor repair
Ci(R) 0,6-07 Direct reuse major repair
Ci(R) 04-0,5: Reuse by Remanufacture between
Ci(R) 0,3: mono-material Recycle
Ci(R) 0,2: Downcycle
Ci(R) 0,1: Waste

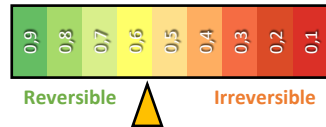
Reused tonnage per material (ton)															Total	Proportion
	Aluminium	Asbestos	Bitumen	Ceramics	Concrete	Glass	Insulation	Linoleum	Plaster	Plastics	Steel	Stone	Timber			
High Reuse Potential (0,7-0,9)	9,1	0,0	0,0	0,0	3,9	7,8	0,1	0,0	15,7	0,4	44,4	0,0	3,9		85,3	5%
Upcycled Medium Reuse Potential (0,4-0,6)	2,8	0,4	8,6	1,6	49,0	0,0	4,6	1,3	9,8	18,9	1027,8	0,5	7,7		1133,0	68%
Low Reuse Potential (0,2-03)	1,1	0,1	0,0	0,2	0,7	0,9	0,0	0,0	0,8	0,0	12,9	0,0	0,0		16,7	1%
Downcycled Reuse Potential (0,1)	0,3	4,1	0,0	1,7	400,3	2,1	0,0	0,5	0,3	0,0	0,0	16,9	0,0		426,2	26%
Total	13,3	4,6	8,6	3,6	453,9	10,8	4,7	1,8	26,6	19,3	1085,2	17,4	11,7		1661,3	100%
Proportion	1%	0%	1%	0%	27%	1%	0%	0%	2%	1%	65%	1%	1%		100%	

Reused tonnage per function (ton)								
	1. Load bearing	2. Enclosing	3. Partitioning	4. Servicing	5. Vertical communication	6. Equipment	Total	Proportion
High Reuse Potential (0,7-0,9)	30,9	19,4	19,3	0,5	0,0	15,3	85,3	5%
Upcycled Medium Reuse Potential (0,4-0,6)	167,0	898,8	66,8	0,3	0,0	0,0	1133,0	68%
Low Reuse Potential (0,2-03)	0,0	14,9	1,8	0,0	0,0	0,0	16,7	1%
Downcycled Reuse Potential (0,1)	343,2	48,2	31,3	0,0	3,6	0,0	426,2	26%
Total	541,1	981,4	119,1	0,9	3,6	15,3	1661,3	100%
Proportion	33%	59%	7%	0%	0%	1%	100%	

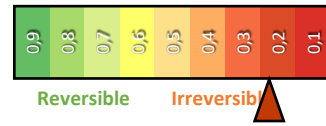
Material substitution/
high value reuse



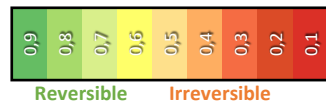
CO2 avoided



Waste produced



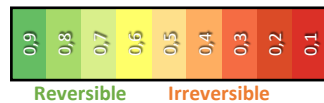
RP/Circularity Indicator



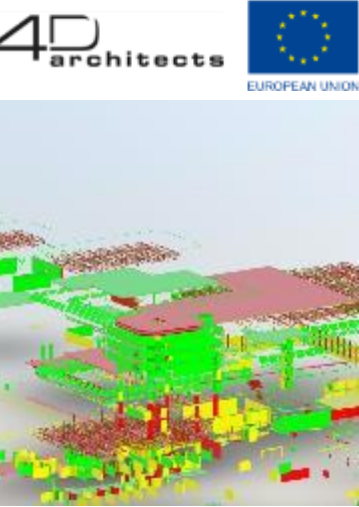
Recycling tonnage



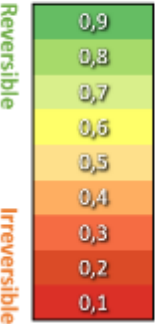
Volume reused



Focus points
Per function
Per material
%



BUILDING
REUSE POTENTIAL





Reuse options:

RP 0,9 = Direct reuse
RP 0,8 = Direct reuse by minor repair
RP 0,7 = Reuse by major repair
RP 0,6 = Reuse by major repair
RP 0,5 = Re-manufacture
RP 0,4= Re-manufacture
RP 0,3 = Mono-material recycle
RP 0,2 = Recycle
RP 0,1 = Waste

Reversible

Irreversible

0,9

0,8

0,7

0,6

0,5

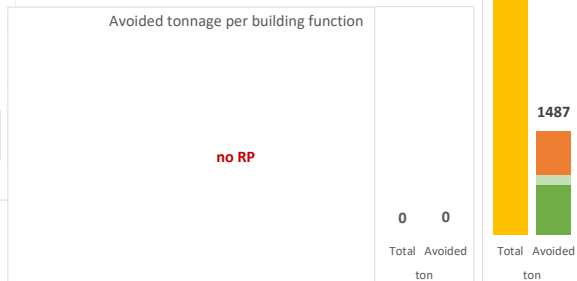
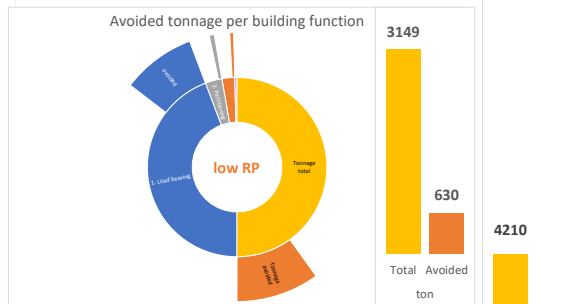
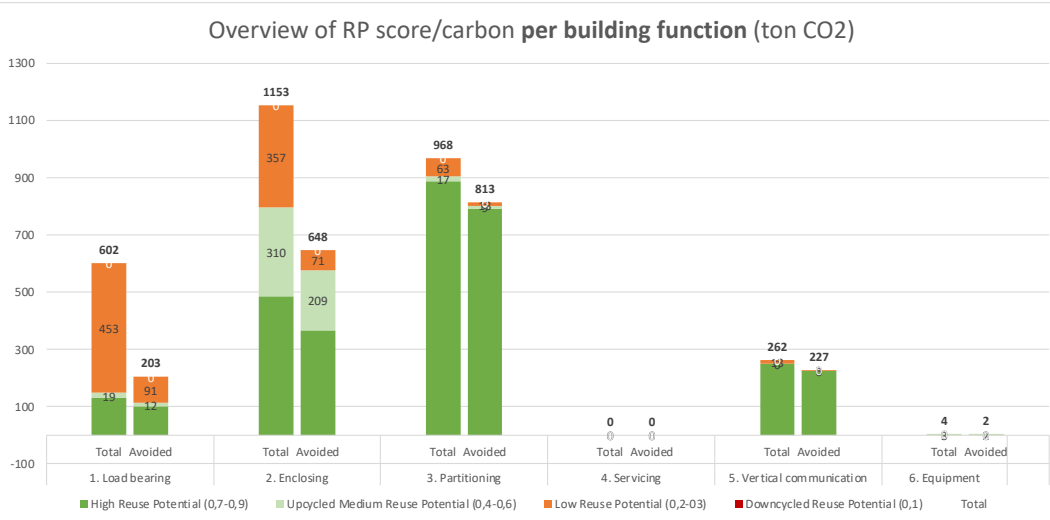
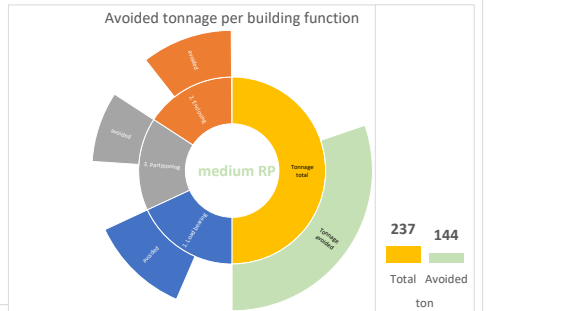
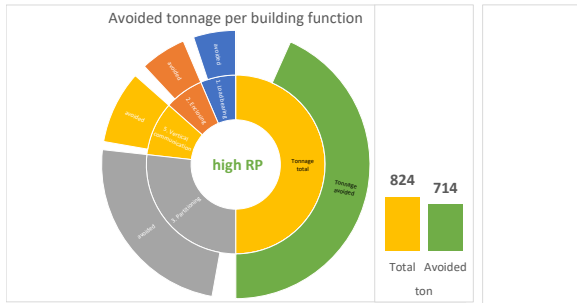
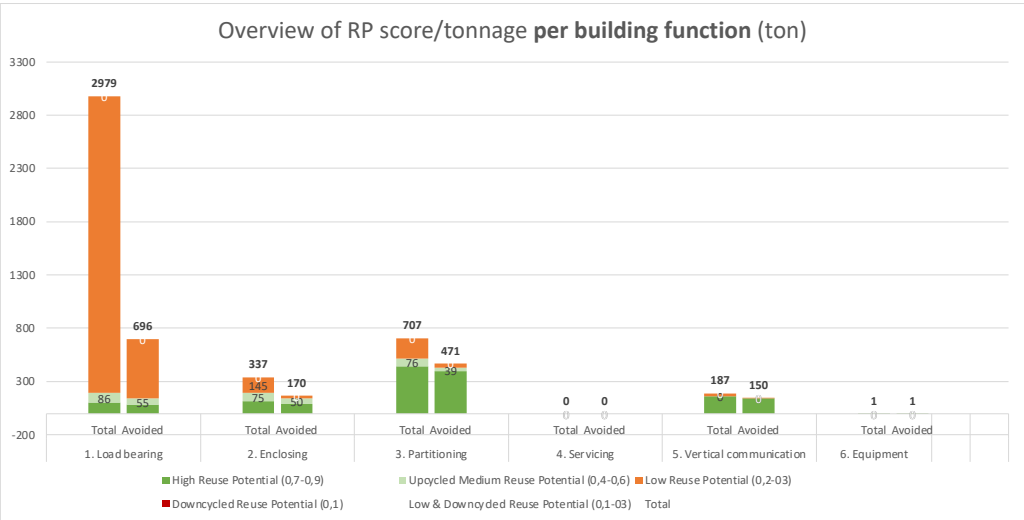
0,4

0,3

0,2

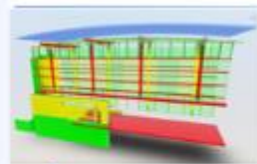
0,1

Avoided tonnages and CO2 per reuse option



Reversible BIM Projects | Reuse Potential

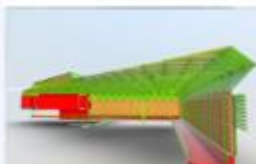
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VSG station France

Description of Projects

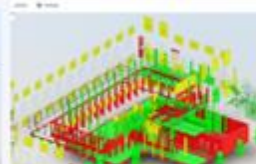
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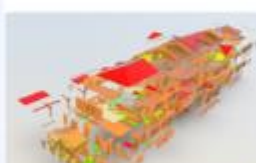
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Reversible/Green Building

NEWS

Circulair project





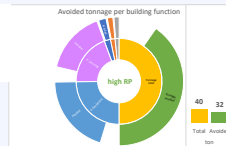
Reversible BIM

VILOGIA

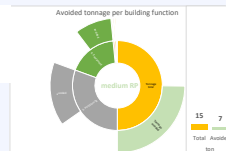
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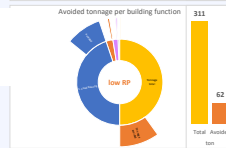
11% direct reuse



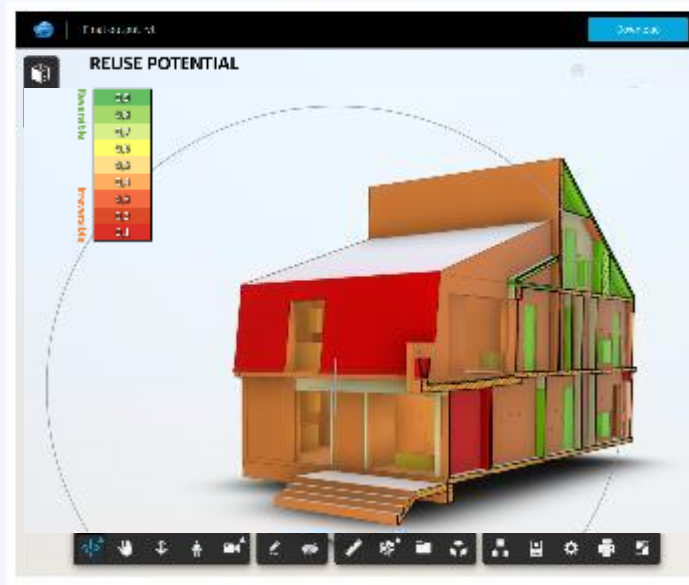
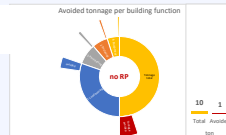
4% reuse by reparation



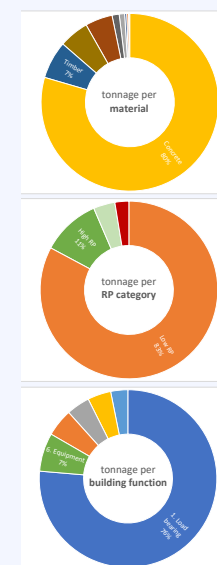
83% recycling



2% waste



Reversible Building
Circularity profile 3
Reversible Building
Circularity profile 1
Reversible Building
Circularity profile 2
Reversible Building
Circularity profile 3
Reversible Building
Circularity profile 4



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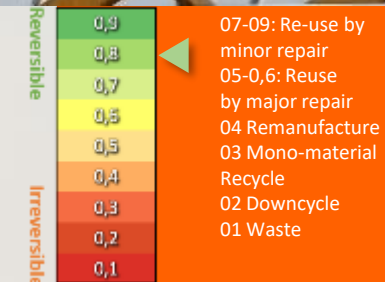
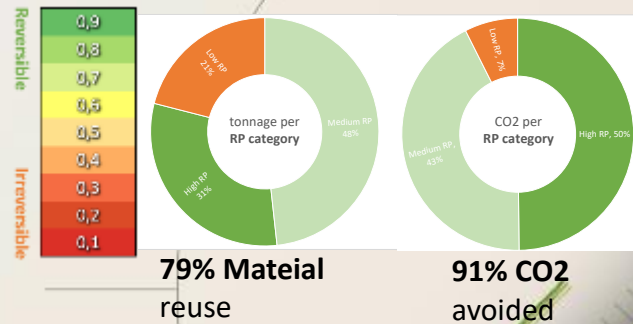


REVERSIBLE BIM

Digital inventory of reus potential

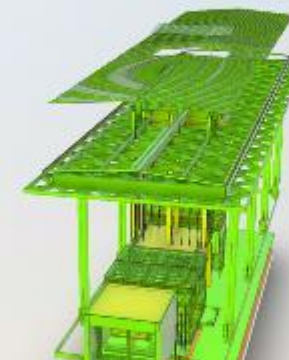
©E.Durmisevic 2019 *4D architects

Circular ladder



©Model Durmisevic 2019/4D *EU BAMB

Reversible
BIM
Reuse Potential
Tool
1. Model 2. Data 3. Use 4. BIM
4D
BIM
BIM

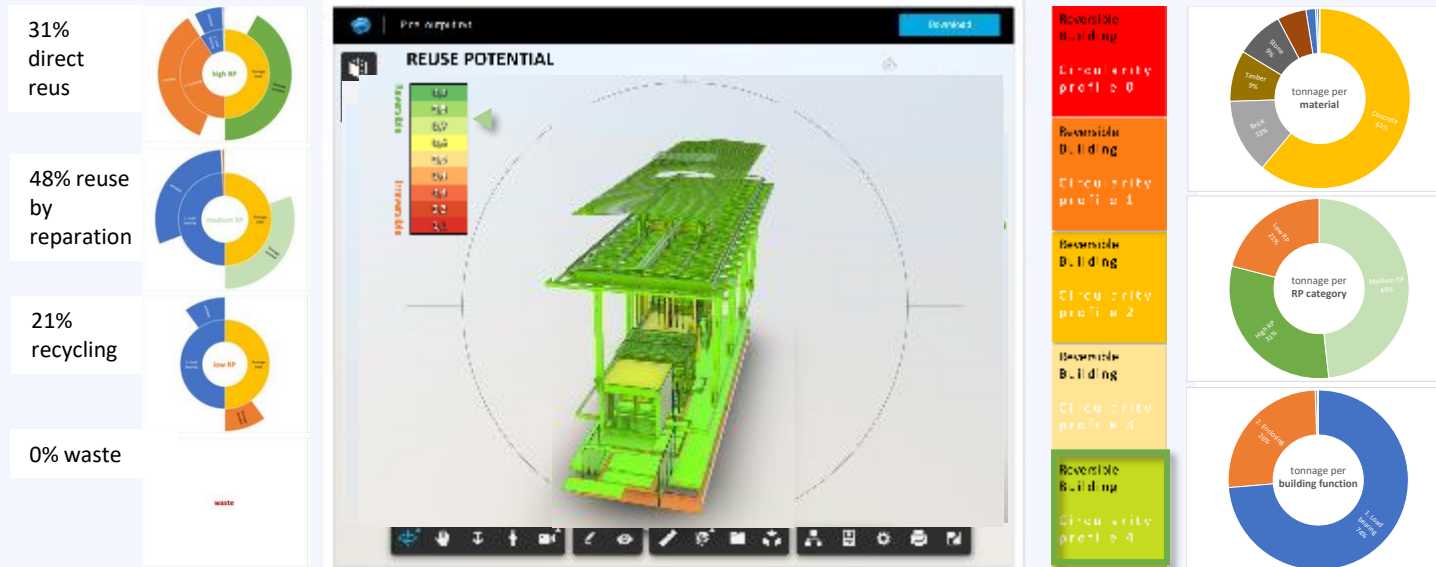




Reversible BIM

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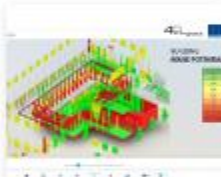
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Circularity meter / index

Partners

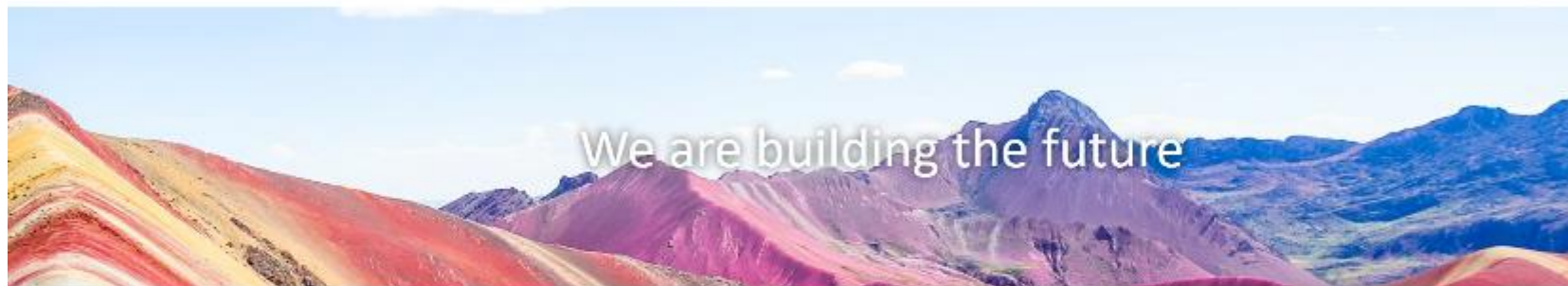


News



GTB Lab Blog

**GTB Lab**
Construction
Blog

[Home](#) > [Circular building mapping](#)

Circular building mapping

☐ Outstanding projects	☐ Refurbishment hubs	☐ Circular building products
☐ New construction projects	☐ Material recycling	☐ Materials
☐ Planned construction projects	☐ Certification labs	
☐ Transformation projects	☐ Design & Living labs	
☐ Policies	Type of building transformation Make a choice	City Amsterdam
☐ Guidelines		Belgium
☐ Toolkit		Make a choice



Summary of selected markers

Circularity Meter

Circularity meter will assess reuse potential and circularity of materials within a building indicating the potential material flows related to the circularity score. It monitors city building material flows and enables to identify the gap between the linear and circular economy in built environment, per region/city.



City material flows monitoring

[Show city material flows >](#)

News

Outstanding Projects:



News:



Data Sets for the city material flow monitoring

CB Knowledge Bank - data capture template - New Building Projects/

GENERAL									
Project name	Address	URL	Brief Description	Year of construction	Building type	Gross area	Tonnage of material per material type	Tonnes of carbon emissions (equivalent of <ton CO2 x 1,225> acres of trees growing for a year)	Tonnage of reused material per material type
									Tonnage of new material saving

CB Knowledge Bank - data capture template - Refurbishment/transformation projects

CB Knowledge Bank - data capture template - Reconstruction

Project name	Address	URL	Brief Description	Year of construction/transformation	Building Type	Gross area	Tonnage of material	Tonnes of carbon emissions (equivalent of <ton CO2 x 1,225> acres of trees growing for a year)	Tonnage of reused material	Tonnage of new material saving within the project
--------------	---------	-----	-------------------	-------------------------------------	---------------	------------	---------------------	--	----------------------------	---

CB Knowledge Bank - data capture template - specific projects/ small scale project

Project name	Address	URL	Brief Description	Year of construction/transformation	Type of intervention/renovation, kitchen renovation	Gross area	Tonnage of material per material type/ m2 per material type	Tonnes of carbon emissions (equivalent of <ton CO2 x 1,225> acres of trees growing for a year)	Tonnage of reused material	Tonnage of new material saving within the project
--------------	---------	-----	-------------------	-------------------------------------	---	------------	---	--	----------------------------	---

CB Knowledge Bank - data capture template - transformation public spaces

GENERAL					Circularity					
Name: Public space	Address	URL	Brief Description	Year of construction	Type of public space	Gross area of new green surfaces	Number of new trees (equivalent of 1 ton CO2)	Gross area of water absorbing area	Gross area of CO2 absorbing area	Tonnage of reused material

CB Knowledge Bank - data capture template - mapping of material streams

GENERAL					Certainty					
Name: Public space	Address	URL	Brief Description	Year of construction	Type of public space	Gross area of new green surfaces	Number of new trees (equivalent of 1 ton CO2)	Gross area of water absorbing area	Gross area of CO2 absorbing area	Tonnage of reused material

CB Knowledge Bank - data capture template - circularity/renewable energy of industrial sites



Circular building mapping

Circular building mapping

☐ Outstanding projects
 ☐ New construction projects
 ☐ Planned construction projects
 ☐ Transformation projects

☐ Refreshment hubs
 ☐ Material recycling
 ☐ Certification labs
 ☐ Design & Living labs

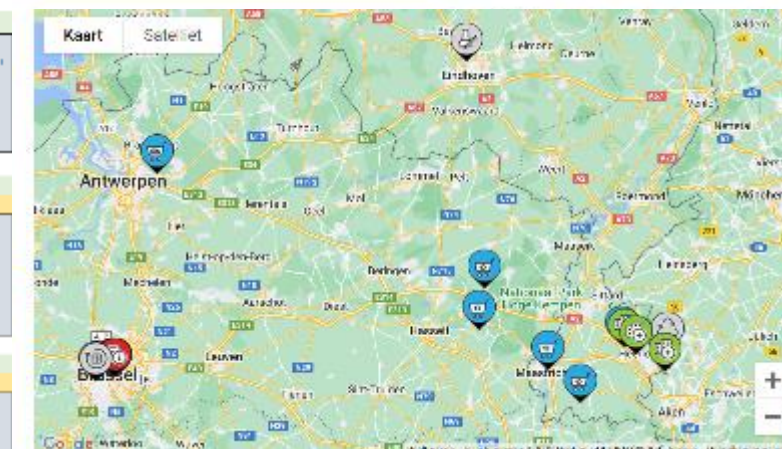
☐ Circular building products
 ☐ Materials

☐ Policies
 ☐ Guidelines
 ☐ Initiatives

Type of building transformation
 Make a choice

City
 Amsterdam

Radius
 Make a choice



Summary of selected markers

Number of projects	5
Gross floor area	13178 m2
Gross building volume	52508 m3

Materials

Tonnage total property (total)	0 ton
Tonnage total property (leverage)	0 ton
Tonnage reusable materials (avoided waste)	0 ton
- Share reusable materials (avoided waste)	0%
Tonnage reused by repaired materials	0 ton

Circularity Meter

Circularity meter will assess reuse potential and circularity of materials within a building indicating the potential material flows related to the circularity score. It monitors city building material flows and enables to identify the gap between the linear and circular economy in built environment, per region/city.



City material flows monitoring



Show city material flows

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Outstanding Projects



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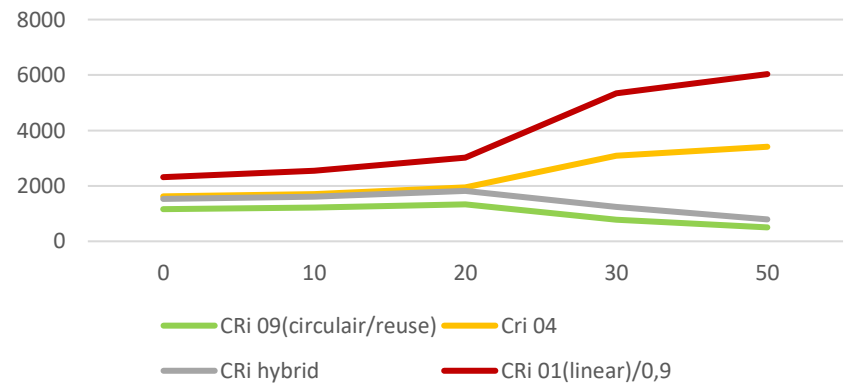
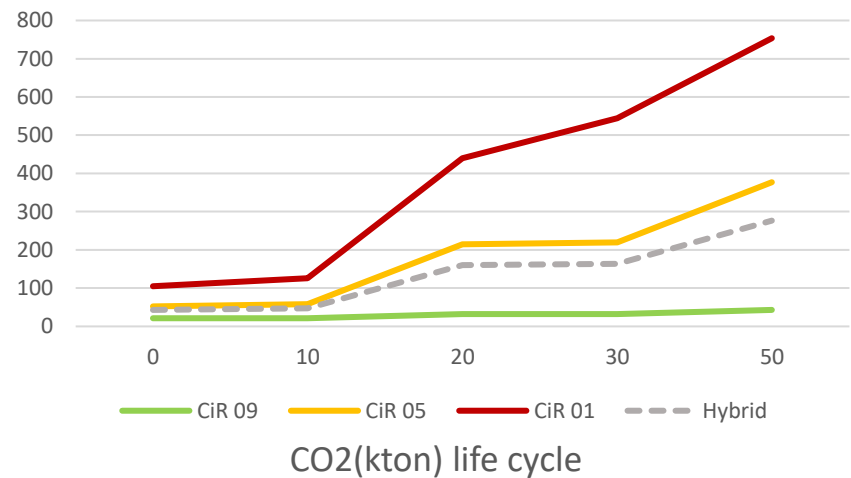
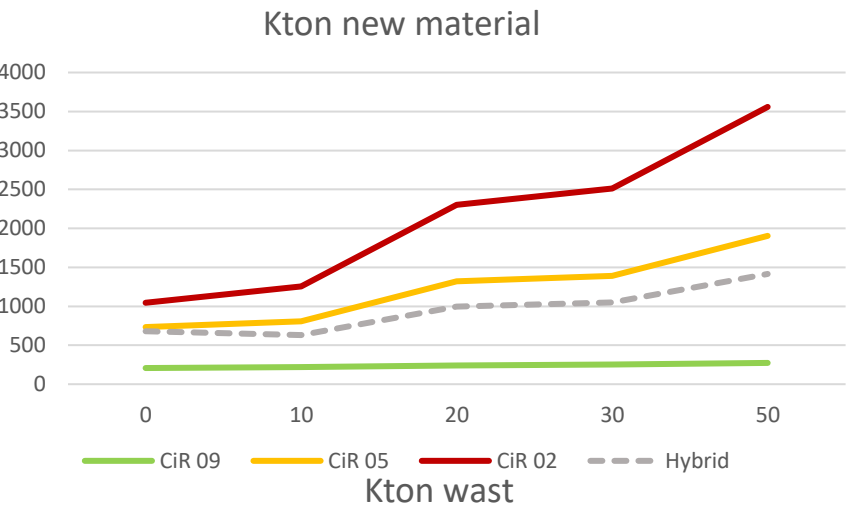
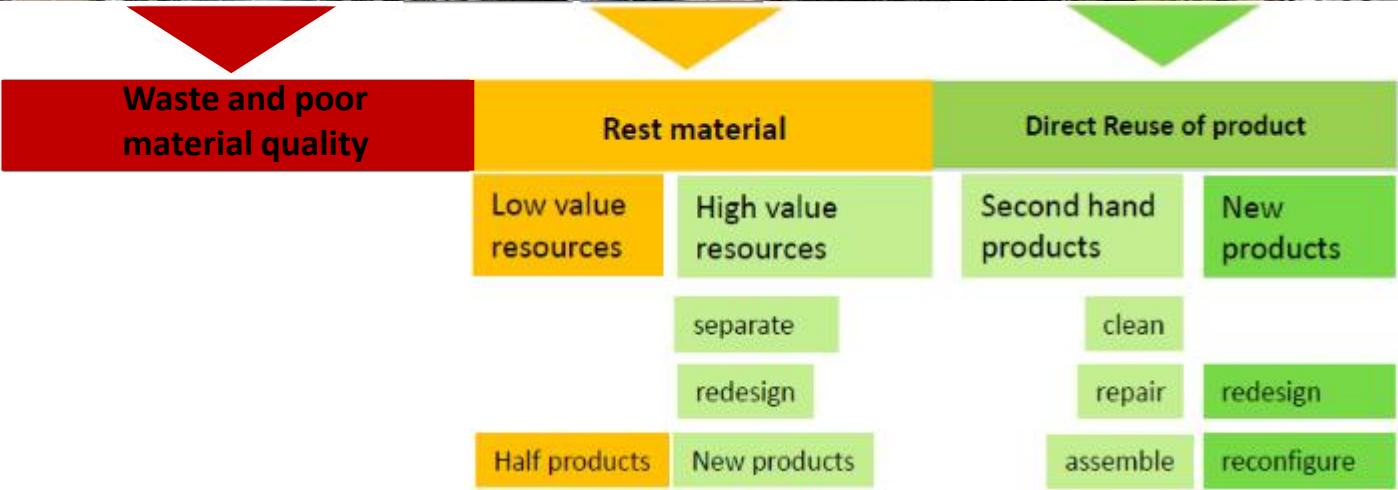


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City material flows:

Product, good quality material and poor material flows



ABCD strategy



Module A:
Base line | Gap analyse | Protocol & tools for the implementation

Module B:
Financial support for the industry and market uptake

Module C:
Implementation pilots and spin off building projects

Module D:
Monitoring and Light house/next developments

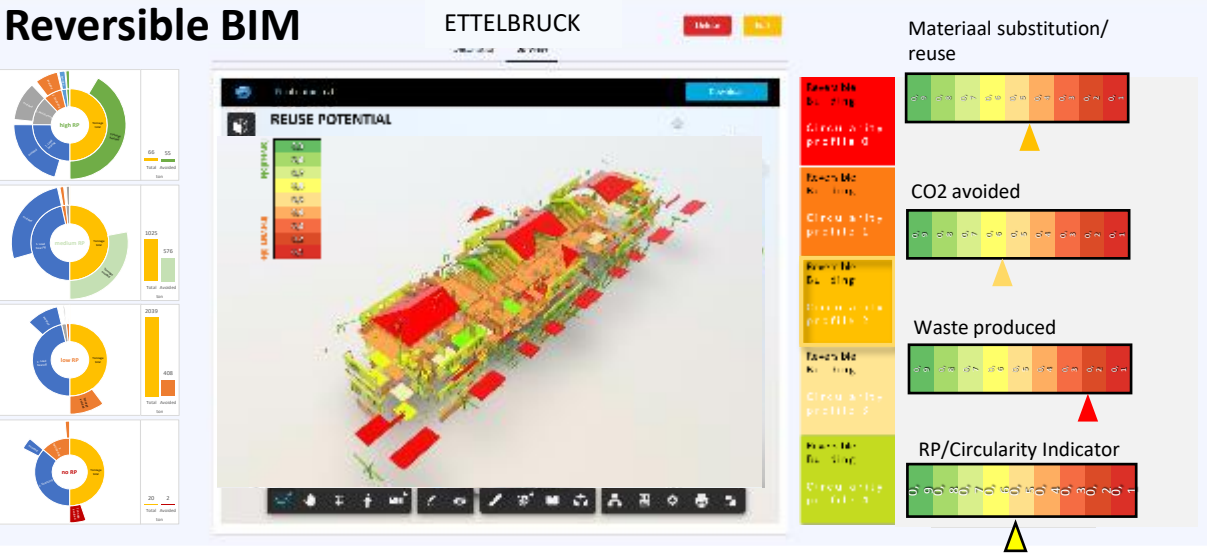


Material environmental impact

Energy & Pollution impact



Reversible BIM



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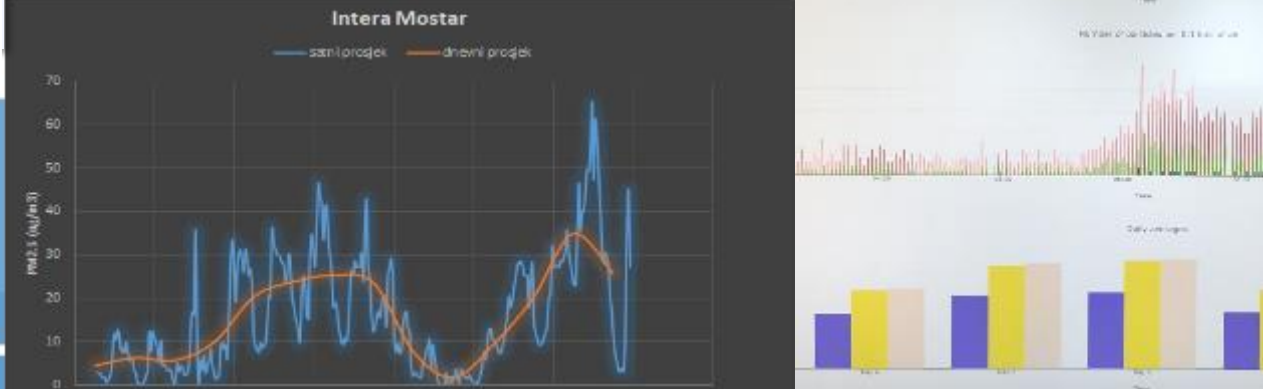
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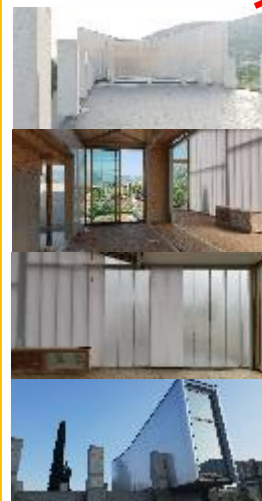


USA Israel Egypt Turkey Japan



The Netherlands

Architect Elma Durmiesvic



B&H

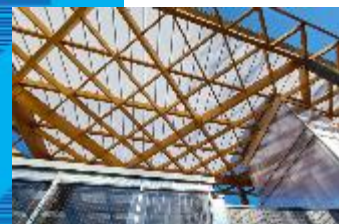
Architect Elma Durmiesvic



12 - 15 Oktober 2022



Green city



Reversible Architecture



Urban farming



E-Mobility



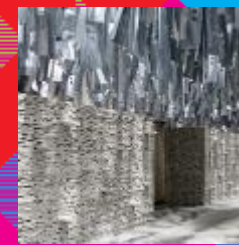
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Green Fashion



Cultural heritage



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Dr.Elma Durmisevic, Founder of SGDF



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