



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



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



Dr. Elma Durmisevic, Founder GTB Lab



Buildings frequently undergo Demolition due to :

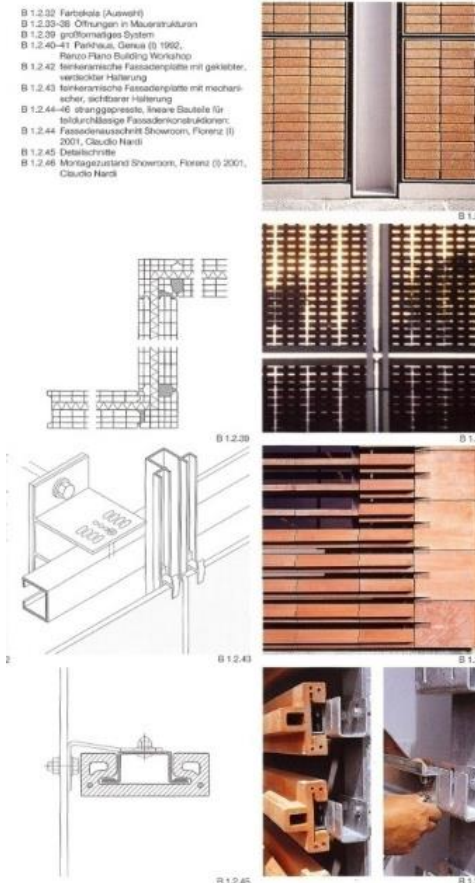
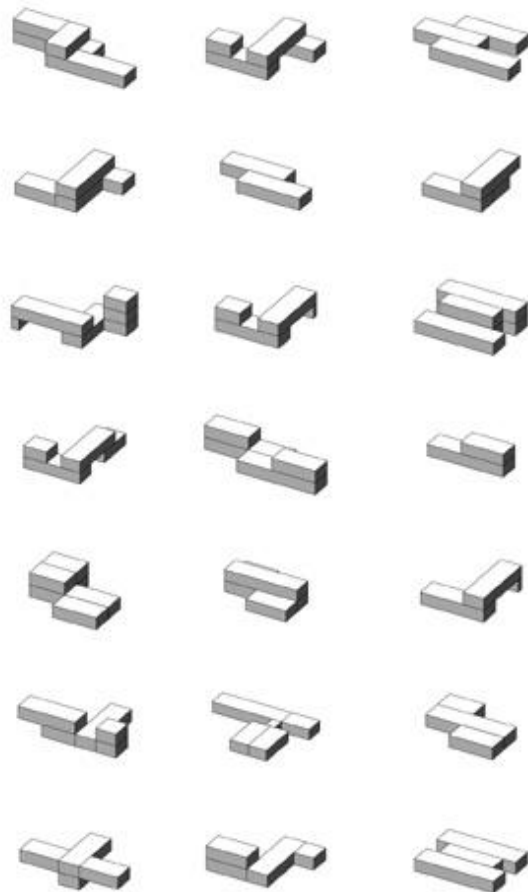
- degradation of materials and more technology dependent components
- Inability to remove and exchange building systems and components
- unfitted for recycling
- difficult to repair
- difficult to access
- difficult to deconstruct



- 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

Future Generation of Buildings REVERSIBLE BUILDINGS

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



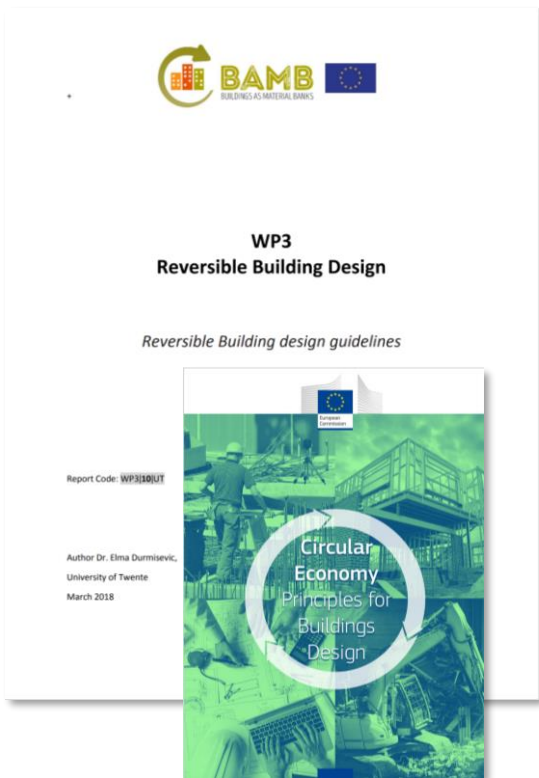
Paradigm Shift towards Circular Buildings and Economy

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



Reversible Building Design Dimensions

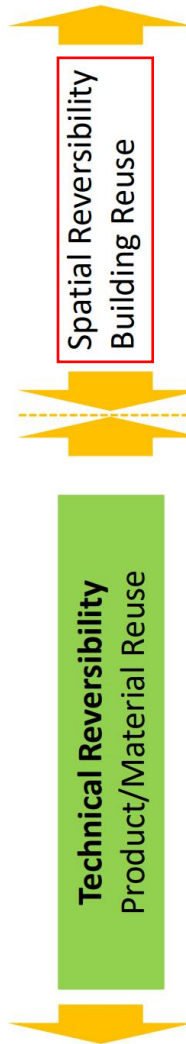
Towards reversible BIM ©Model Durmisevic 2015



THREE DESIGN DIMENSIONS OF REVERSIBLE BUILDINGS

Elma Durmisevic,

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

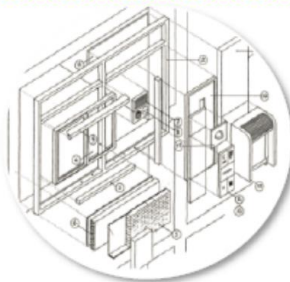


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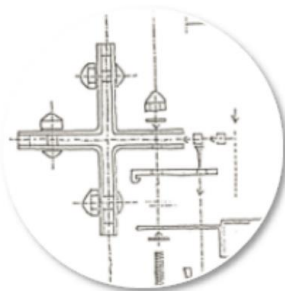
Reversibility of space
Adapt space

2



Reversibility of structure/
Reconfigure /upgrade structure

3



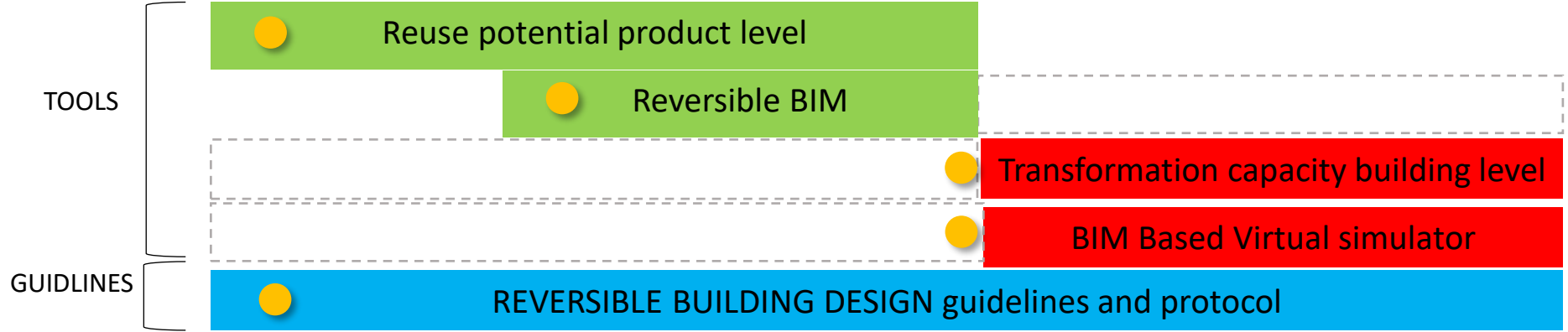
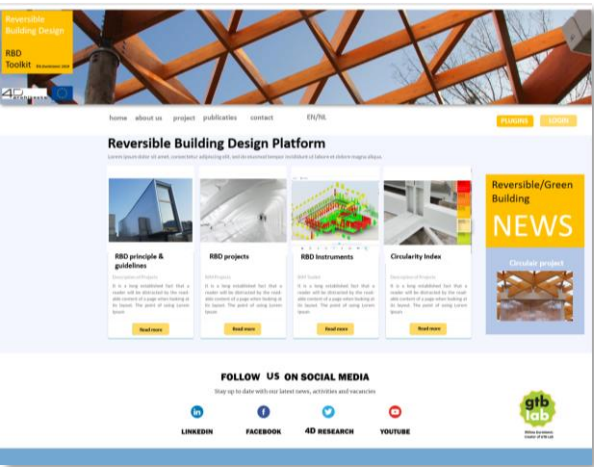
Reversibility of material/
Separate elements/ material

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

Separate materials

Reconfigure/reuse structure

Spatial Reversibility

Adapt

Reversible Building
Circularity profile 0

Reversible Building
Circularity profile 1

Reversible Building
Circularity profile 2

Reversible Building
Circularity profile 3

Reversible Building
Circularity profile 4

RBD Category 0

Spatial reversibility
TC 0,1

Technical reversibility
RP 0,1

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

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%

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%

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%

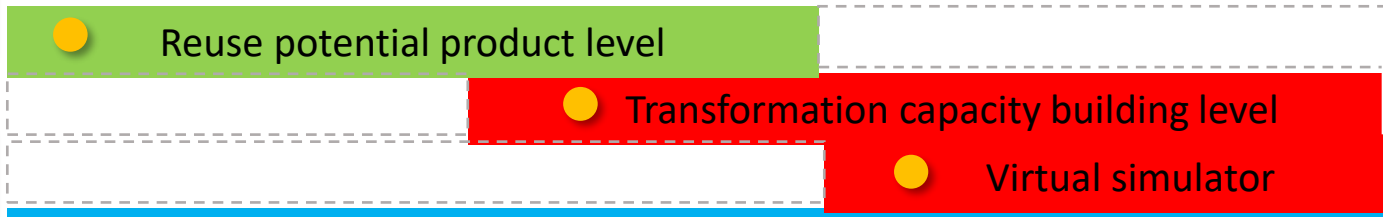
RBD Category 4

Spatial reversibility
TC > 0,7

Technical reversibility
RP > 0,7

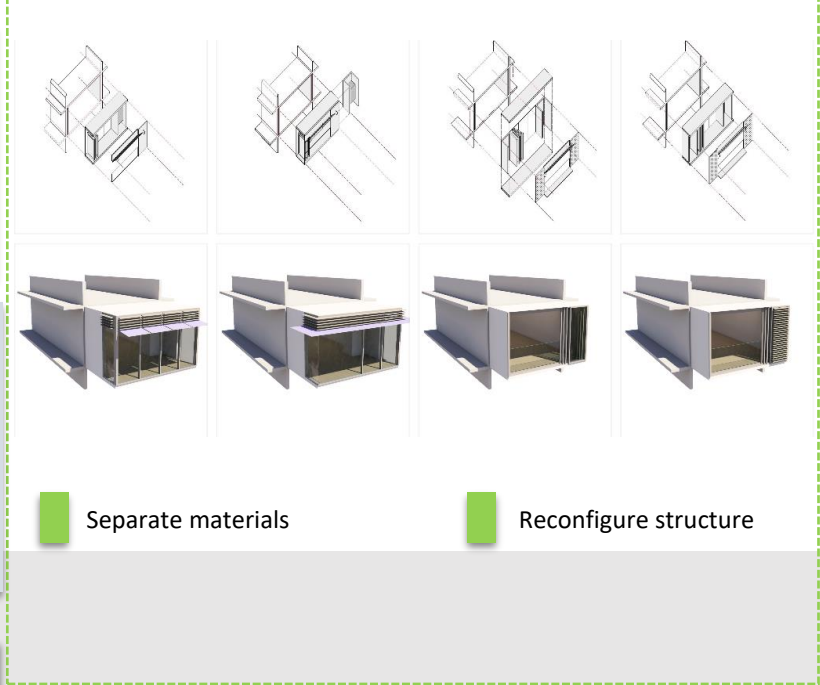
Reuse Building structure more than 70% Materials reused more than 70%

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

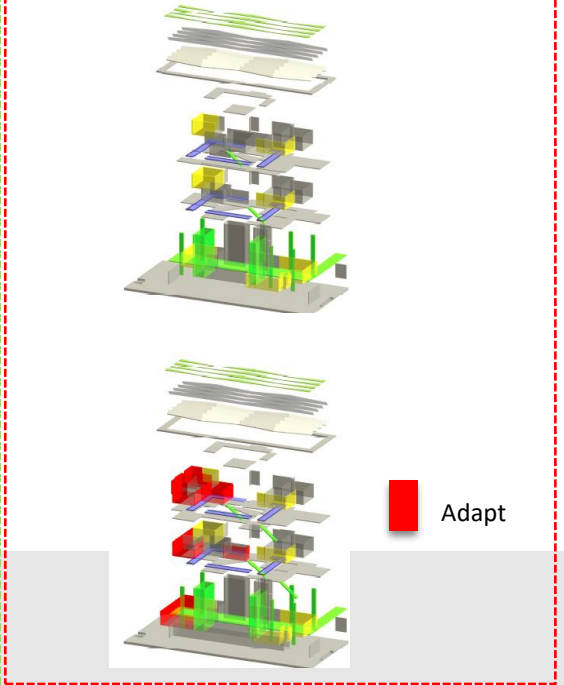


REVERSIBLE BUILDING DESIGN protocol

Technical Reversibility



Spatial Reversibility



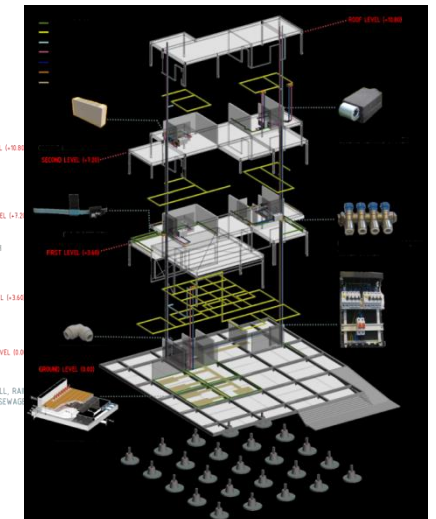
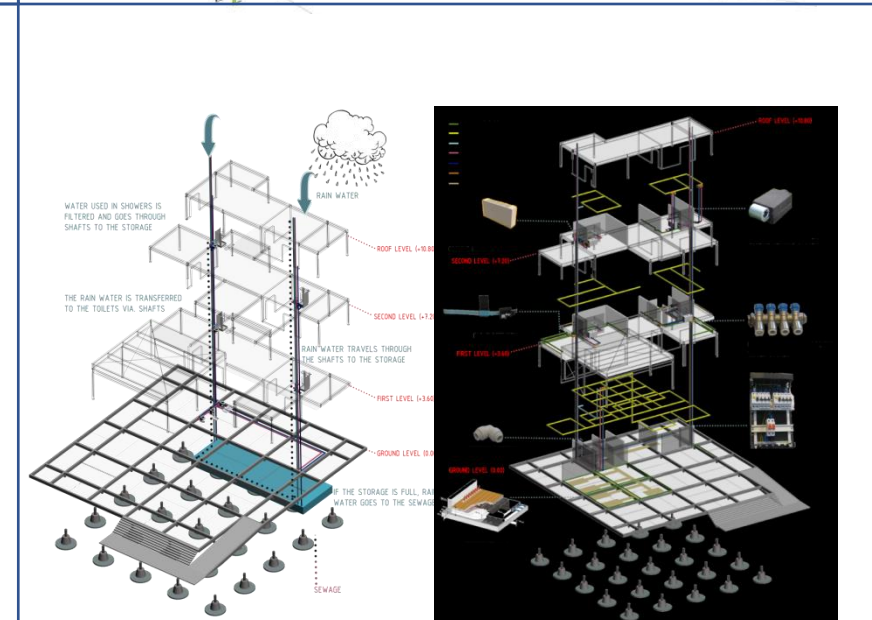
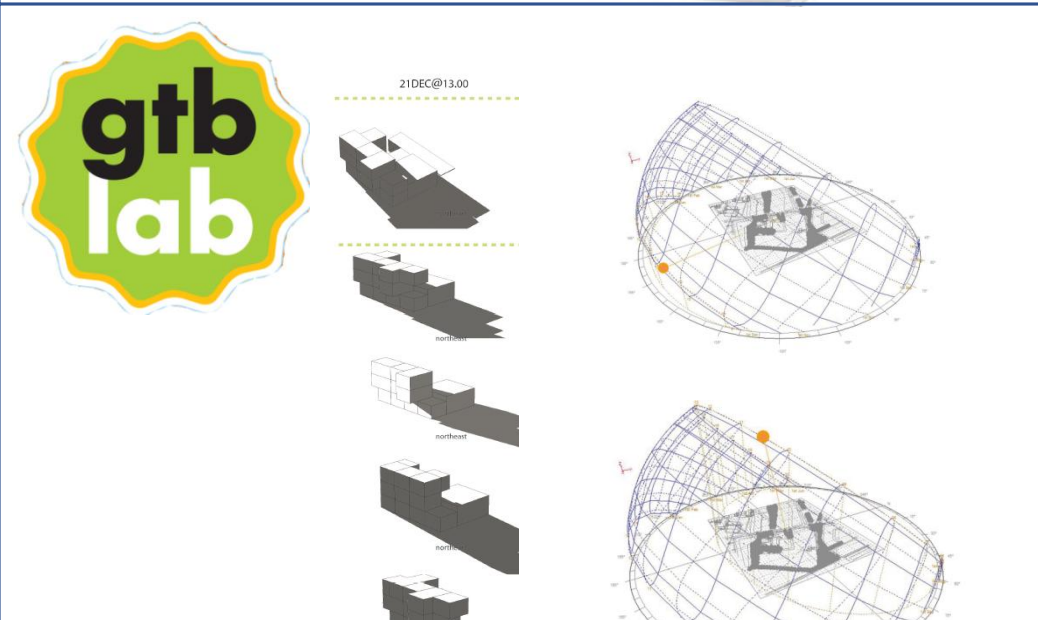
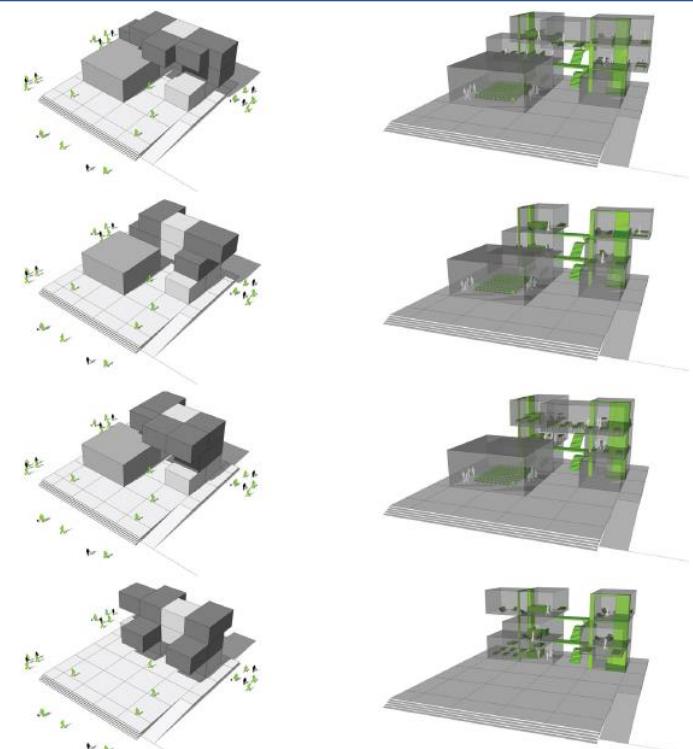


SPACE

Green Transformable BuildingLab



© Elma Durmisevic

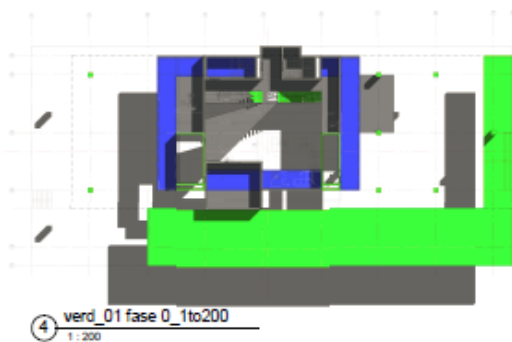




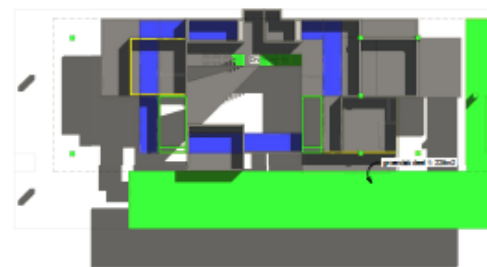
SPACE



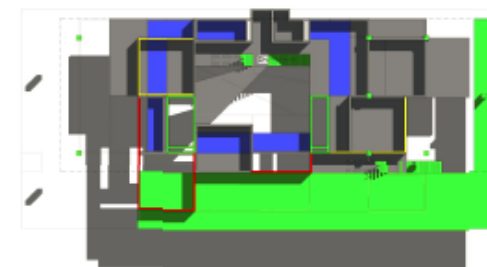
FIRST FLOOR



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1:200

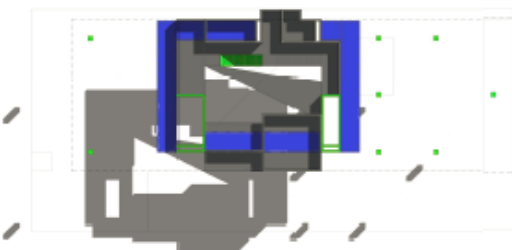


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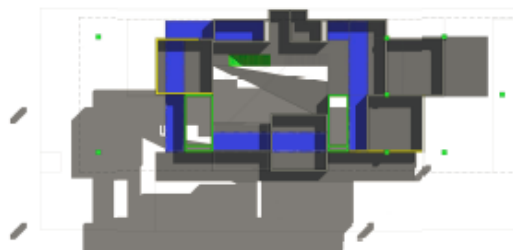


6 verd_01 fase 2_1to200
1:200

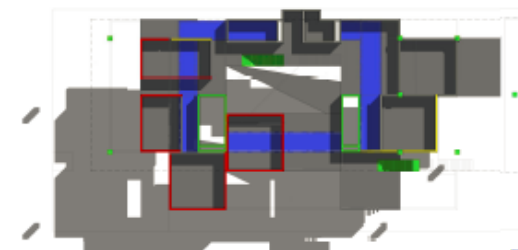
THIRD FLOOR



7 verd_02 fase 0_1to200
1:200



8 verd_02 fase 1_1to200
1:200



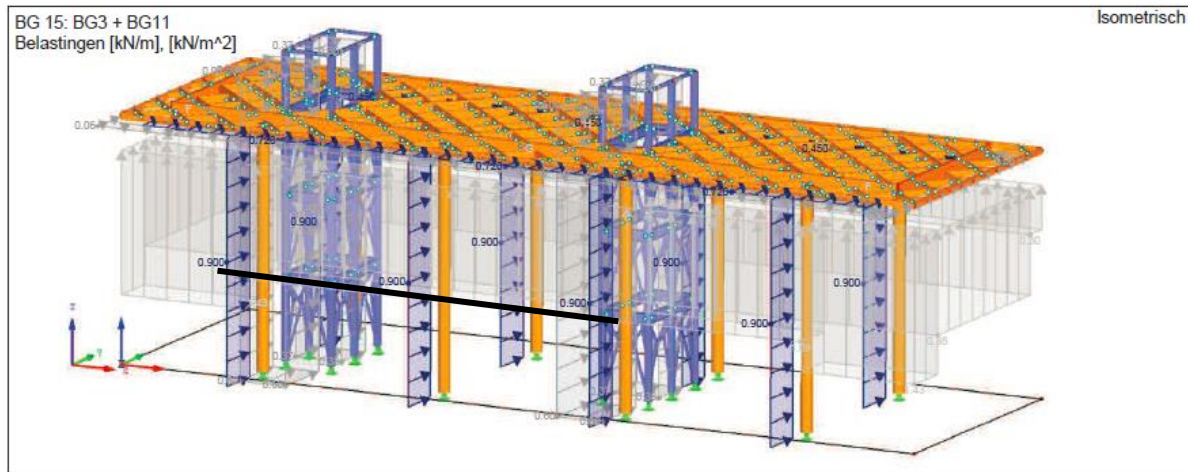
9 verd_02 fase 2_1to200
1:200



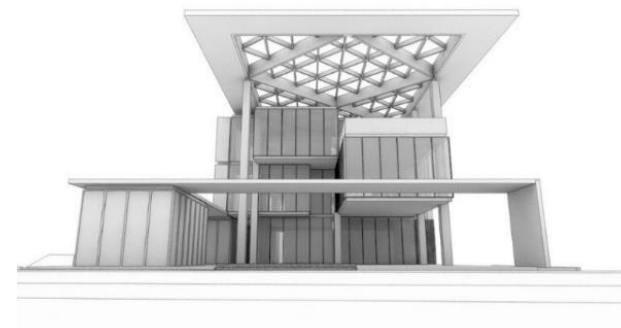
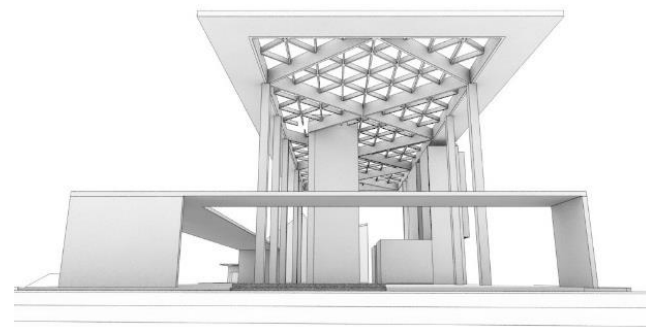
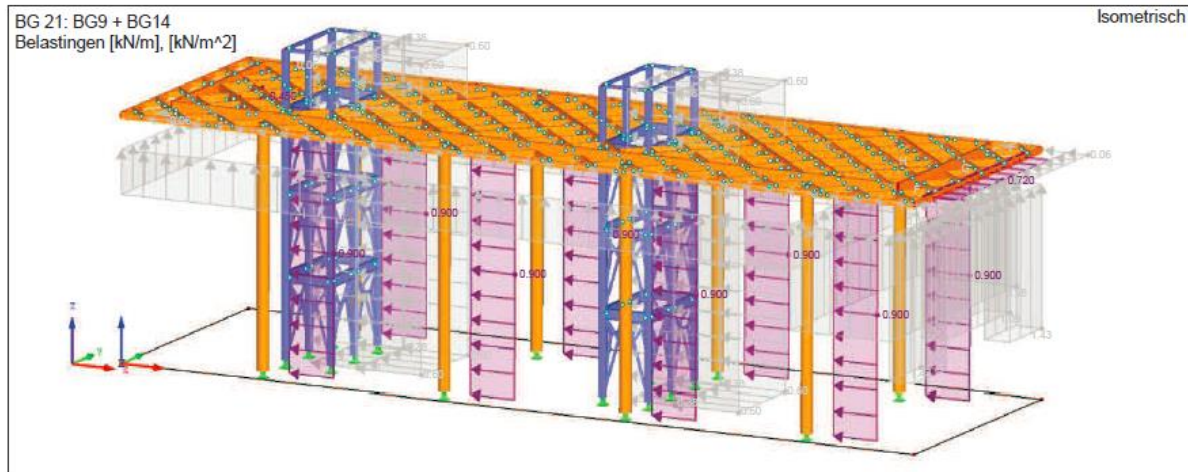
Copyright © 2017 4D Architects



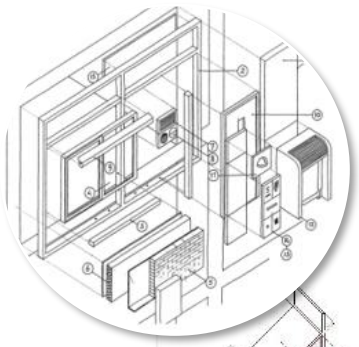
SPACE



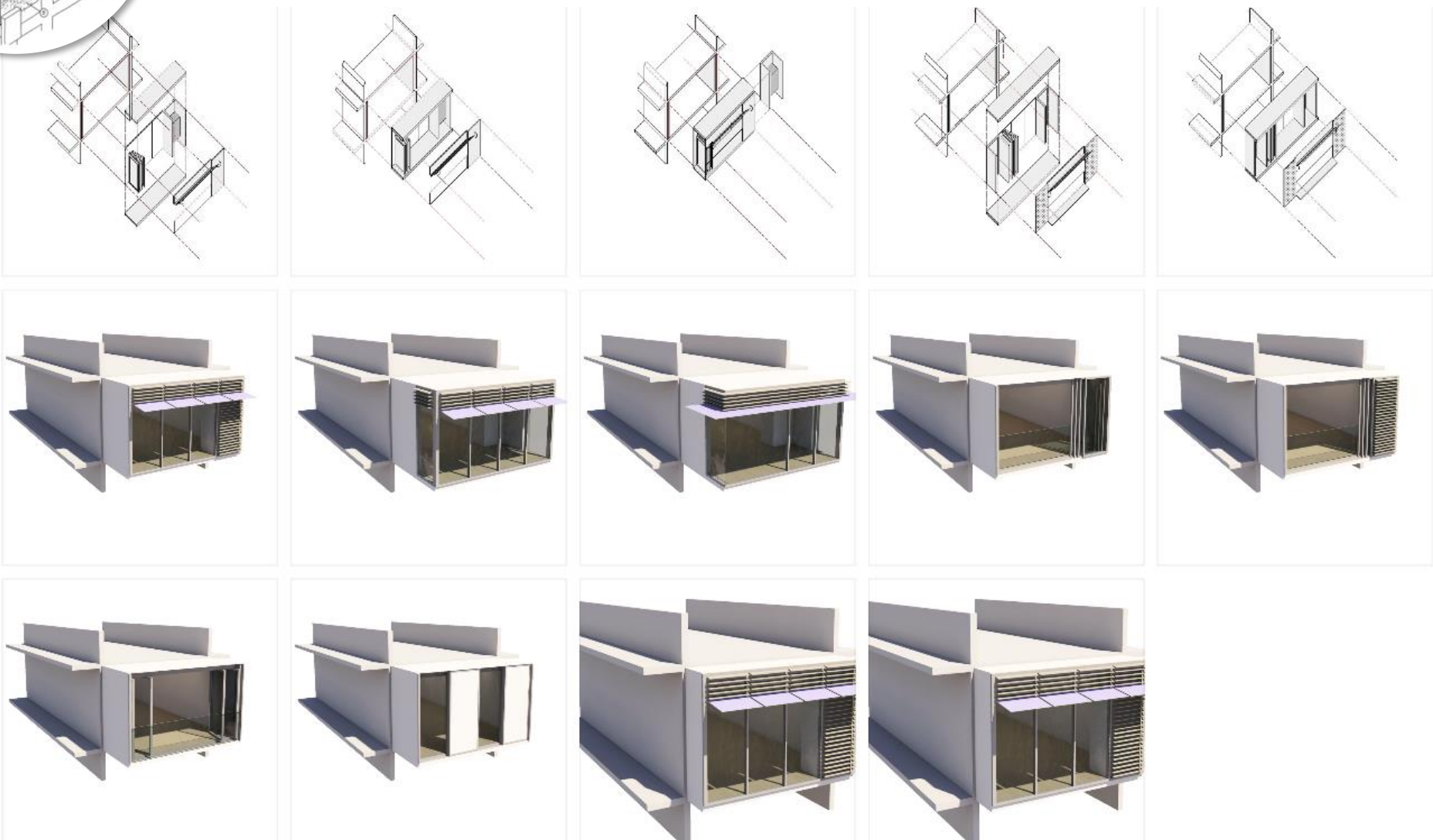
Figuur 5, Wind dak 0.75 kN/m² (basis ⊥)



The core



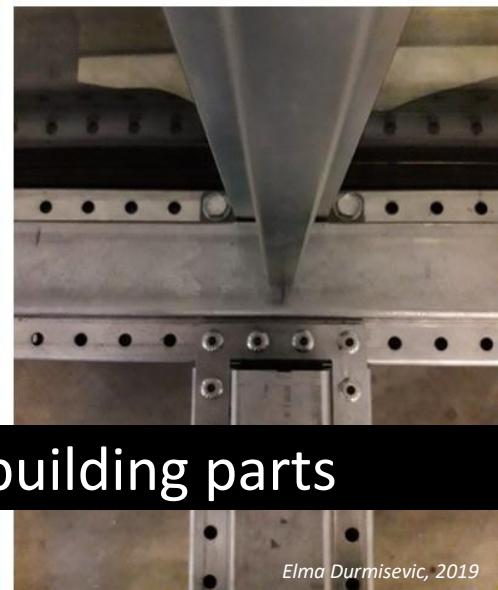
STRUCTURE



Dr. Elma Durmisevic, Founder GTB Lab | Reversible Buildings, The Netherlands

Demonstration of a new Building Generation Strat here –GTBL

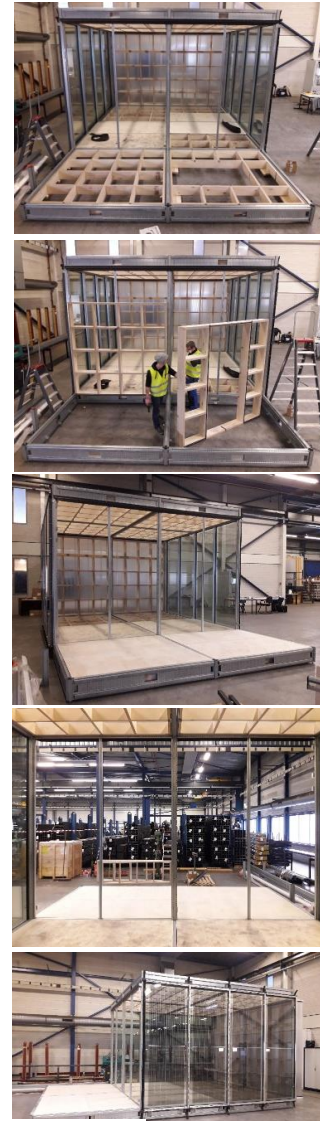
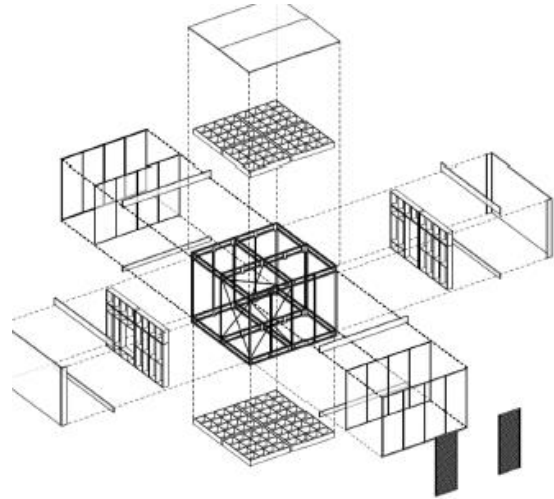
www.greentransformablebuildings.com



Exchangability of building parts

Elma Durmisevic, 2019

Demonstration of circular solution



4D
architects

kloekner metals

ODS Nederland

JANSEN

SKELLET

 **PILKINGTON**


THE NEW MAKERS


rodeca
Transport & Bouwmaterialen

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4D
architects



EUROPEAN UNION

Circular Building

Design of high reuse potential



MATERIAL

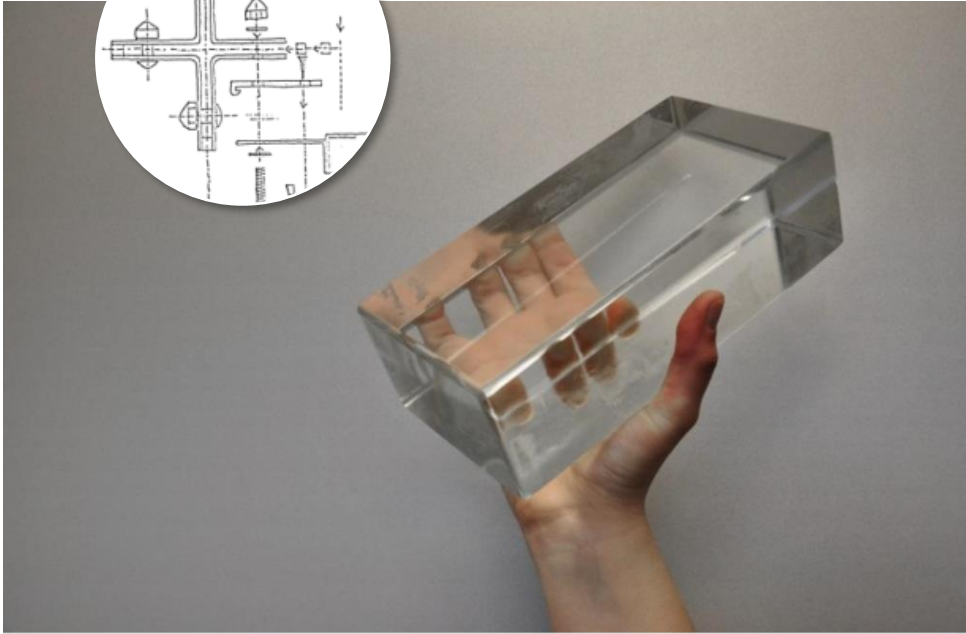
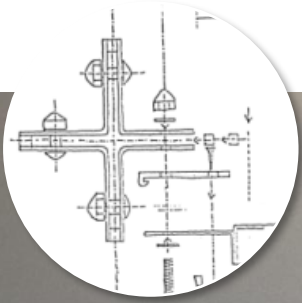
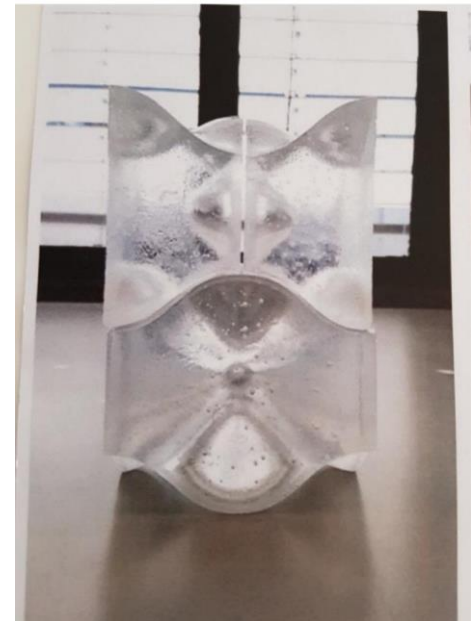
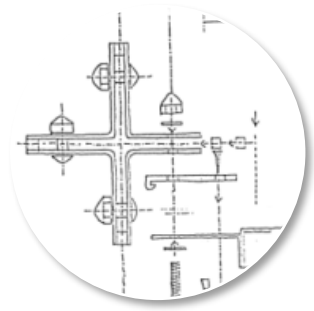


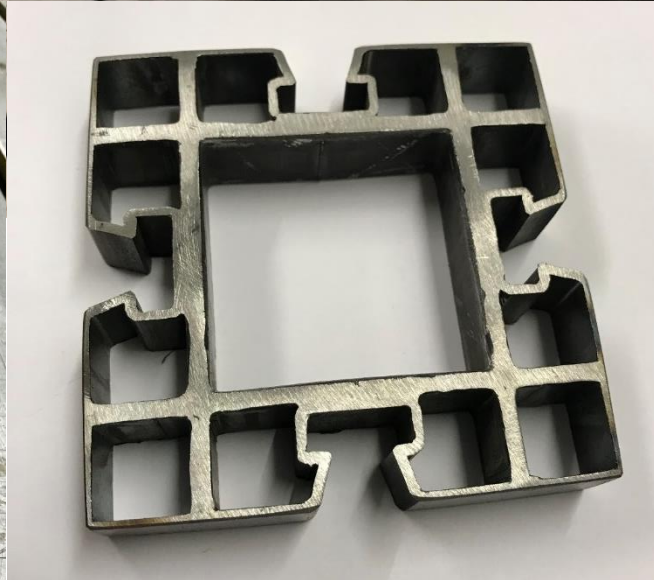
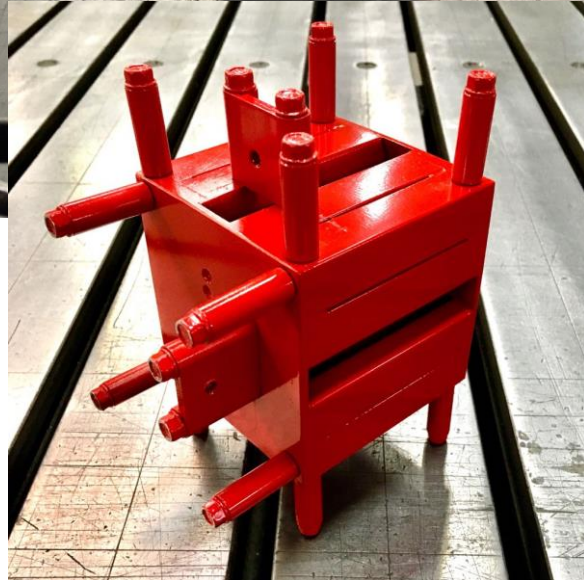
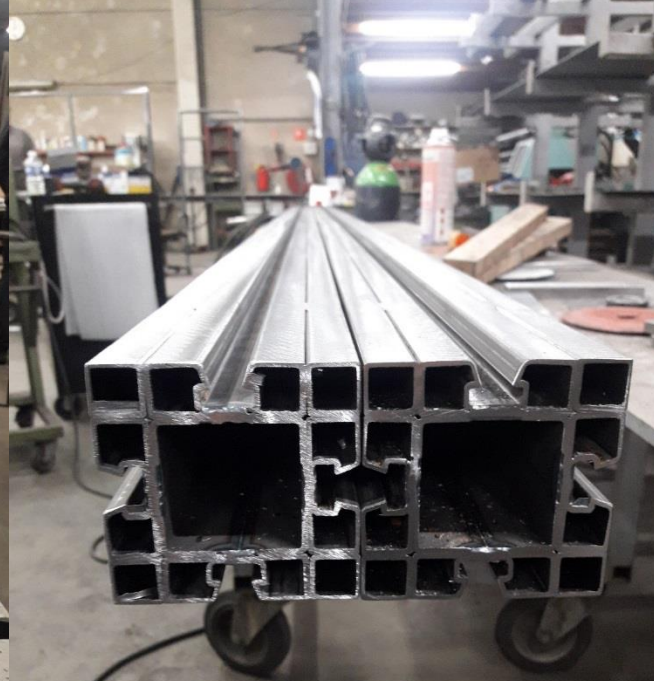
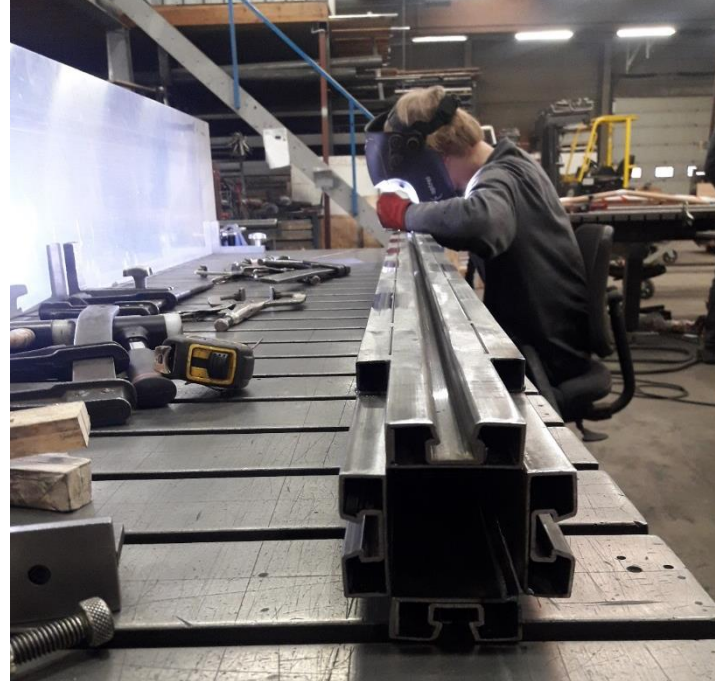
Photo by Faidra Oikonomopoulou



Dr.Elma Durmisevic, founder GTB Lab | Reversible Buildings, The Netherlands



MATERIAL



ODS
klöckner & co multi metal distribution
JANSEN

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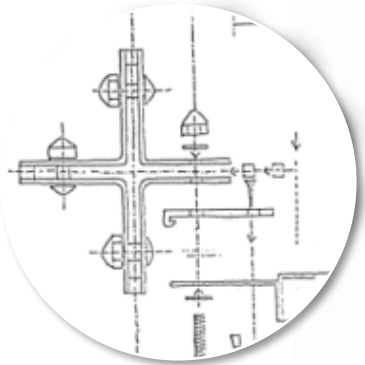
4D
architects

datum
08/2017

Project fase
DO fase

Opdracht
ZUYD

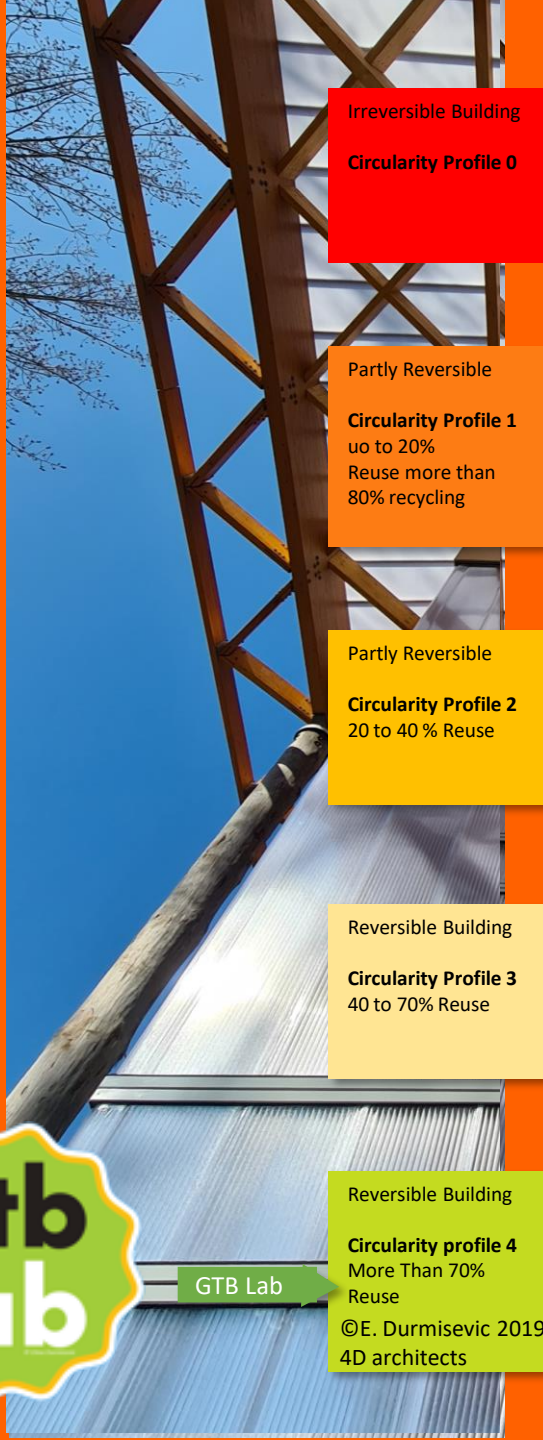
Regio Parkstad | Heerlen



MATERIAL



Eliminate waste



Irreversible Building
Circularity Profile 0

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

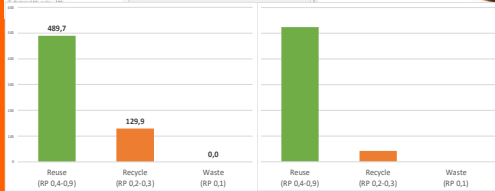
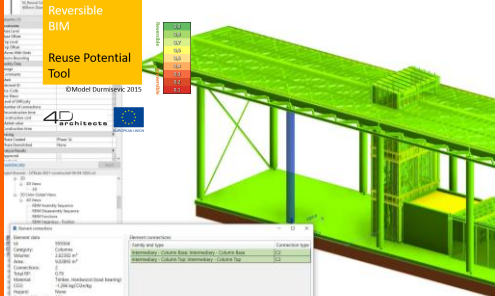
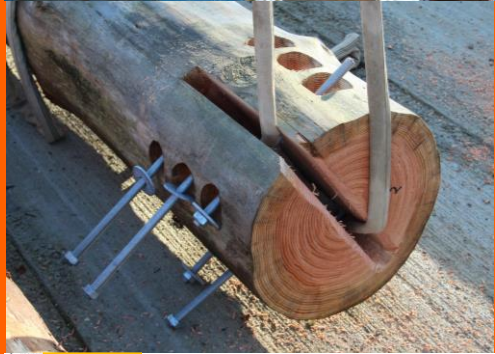
Partly Reversible
Circularity Profile 2
20 to 40 % Reuse

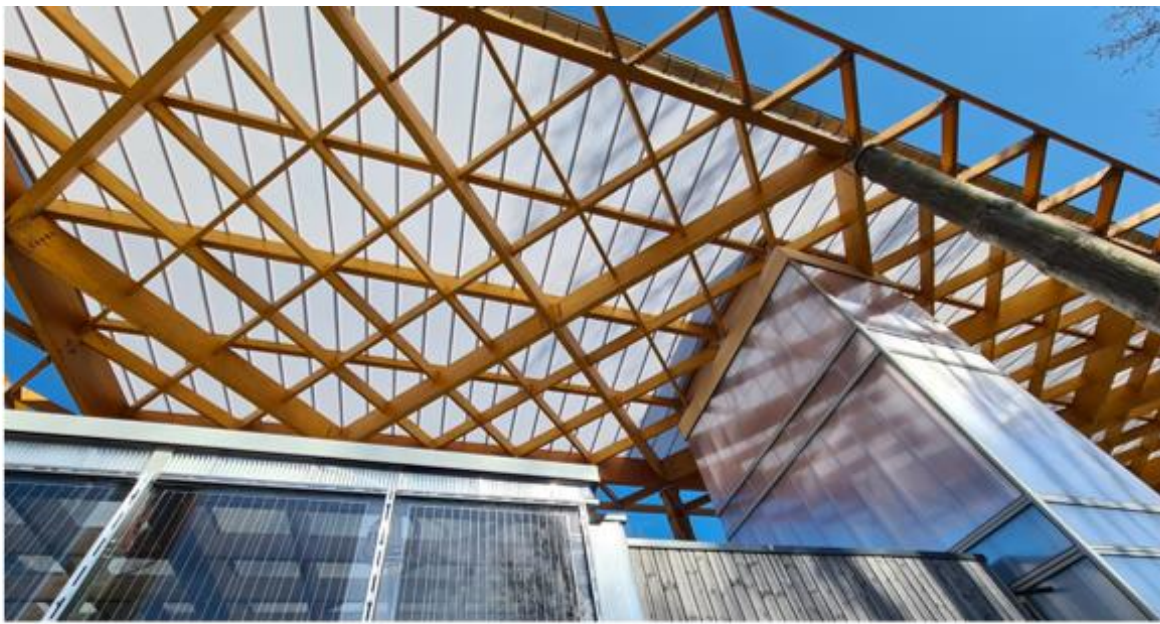
Reversible Building
Circularity Profile 3
40 to 70% Reuse

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



GTB Lab





Architect: Dr.Elma Durmisevic





Architect: Dr.Elma Durmisevic



GTB LAB
FASE 2
11/05/2022



Architect: Dr. Elma Durmisevic

fits

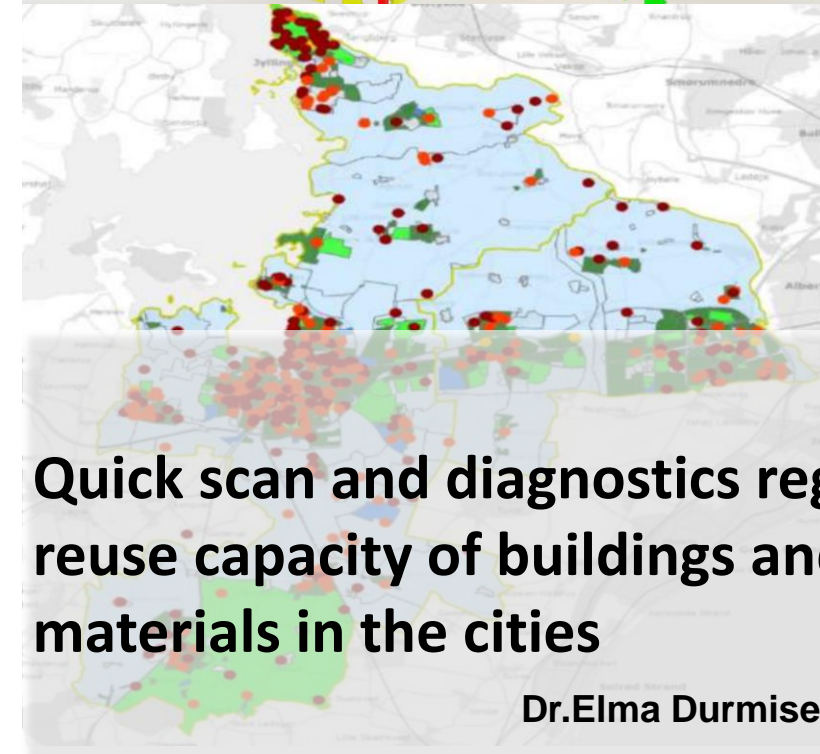
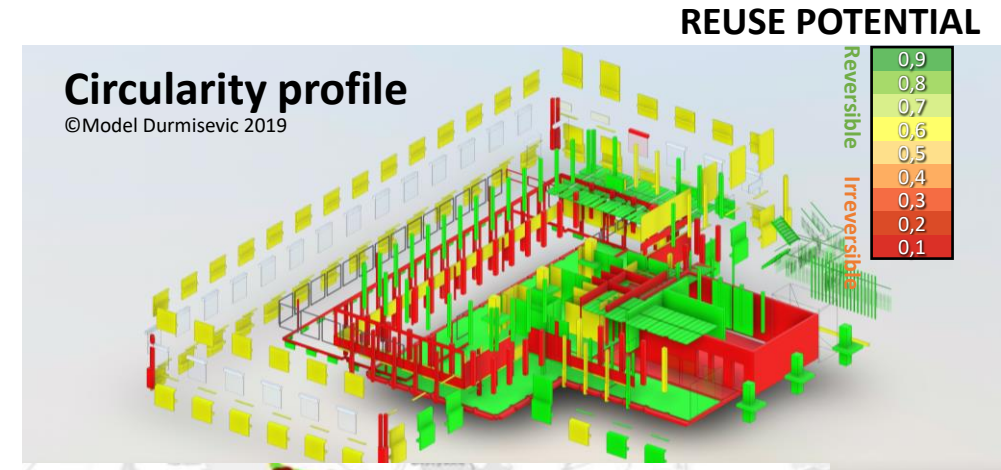


Aim of the LABORATORY FOR GREEN TRANSFORMABLE BUILDINGS

Developing and showcasing circular building solutions



Monitoring, scoring system, inventory



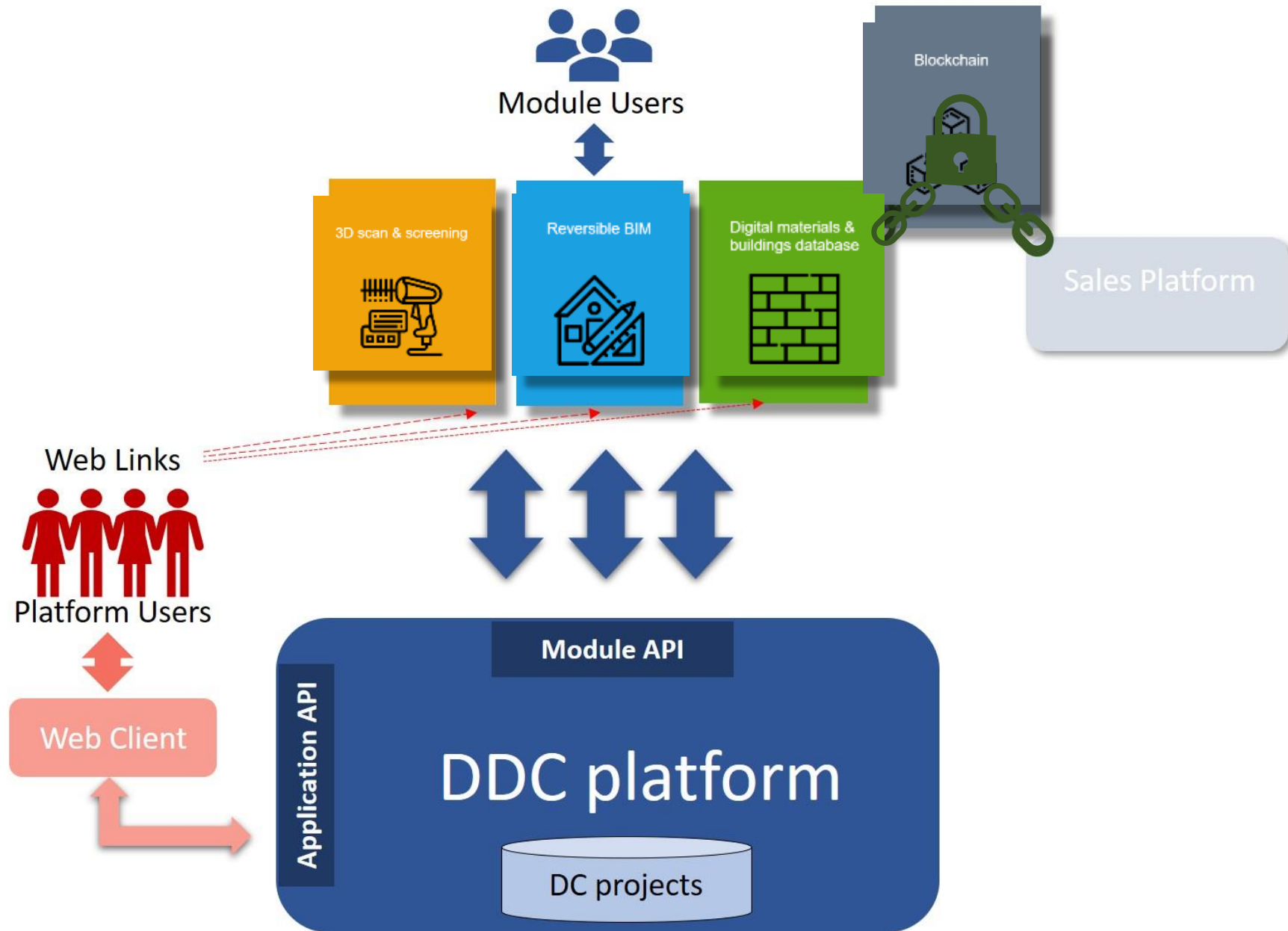
Quick scan and diagnostics regarding reuse capacity of buildings and materials in the cities

Dr.Elma Durmisevic, founder GTB Lab

DDC

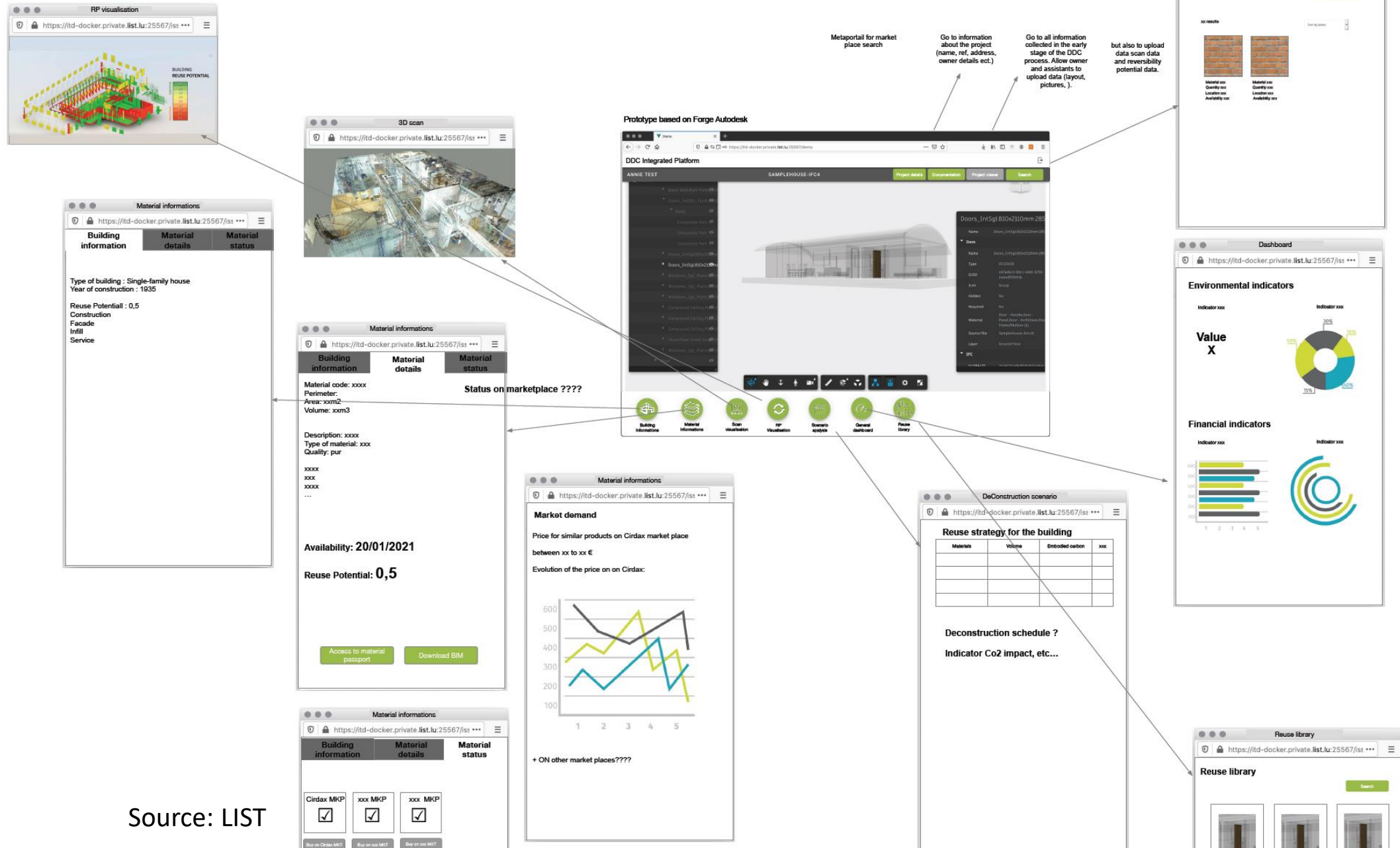
Dr. Elma Durmisevic

25/02/2021



DDC Integrated platform : a decision support tool

A BIM-based dashboard including multiple visualizations



Source: LIST

Reversible
BIM

Reuse Potential
Tool

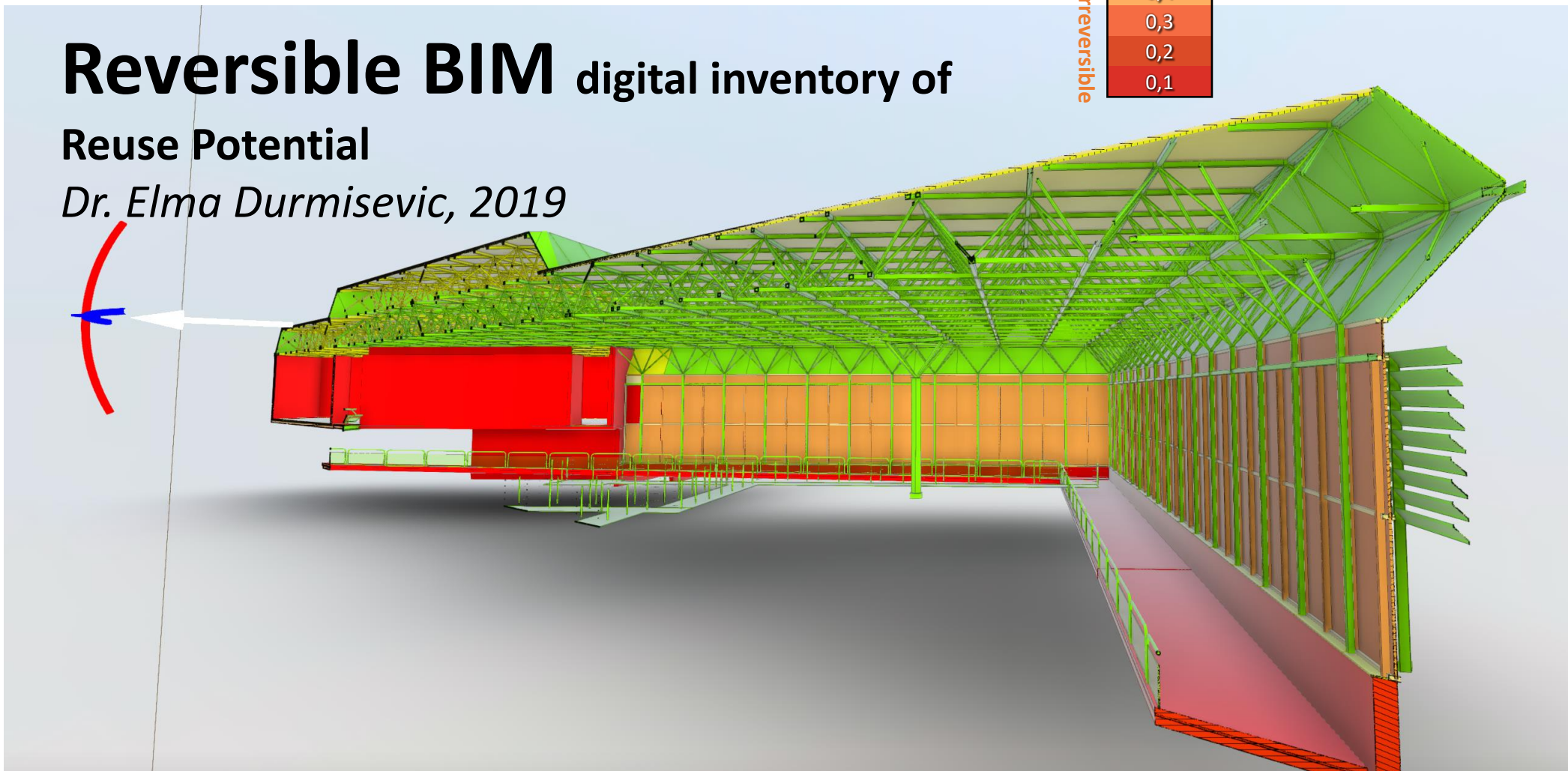
©Model Durmisevic 2015

BUILDING
REUSE POTENTIAL

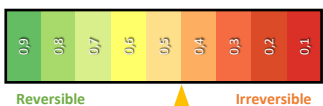


Reversible BIM digital inventory of Reuse Potential

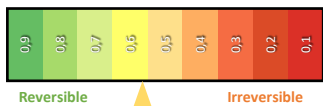
Dr. Elma Durmisevic, 2019



Material substitution/
reuse



CO2 avoided



Waste produced



RP/Circularity profil



Reversible BIM

Reuse Potential Tool

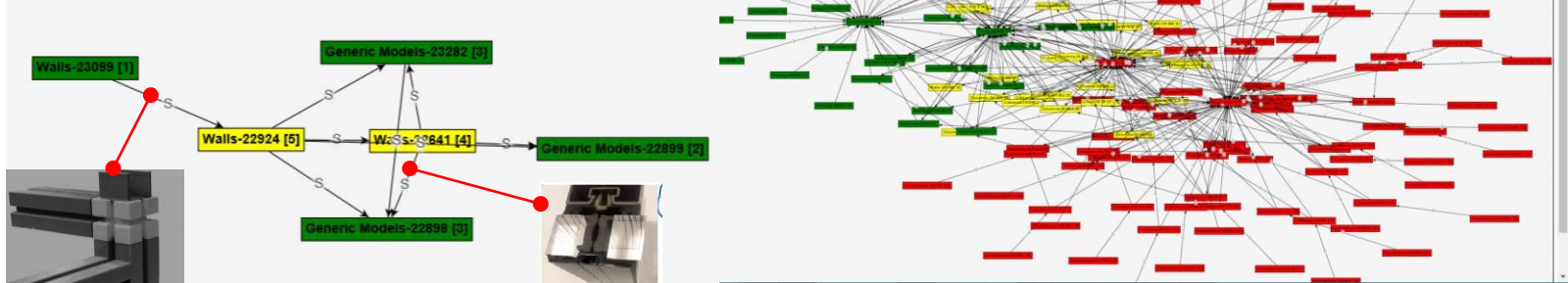
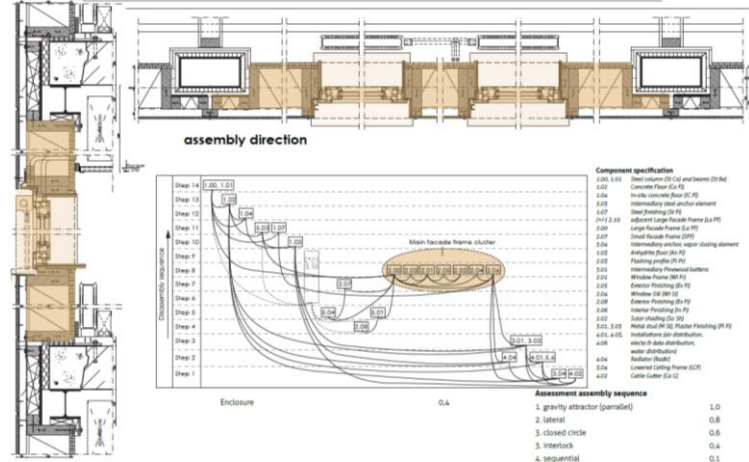
©Model Durmisevic 2018/4D

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Is Structural Element	true
Volume	0.9719999999999999
#Direct Connected Elements	1
#Direct Connected Structural Elements	1
#Direct Supported Elements	1
#Non Direct Dependent Elements	17
#All Dependent Elements	18
Direct Connected Elements (Volume m3)	0.27
#Direct Connected Structural Elements (volume m3)	0.27
Direct Supported Elements (Volume m3)	0.27
Non Direct Dependent Elements (Volume m3)	821.4393629862129
All Dependent Elements (Volume m3)	821.7093629862129

Model 1

```

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0%
Close this dialog when completed successfully
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Start Time: Mon May 22 14:04:
Running script
FeatureClassToGeodatabase...
  
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Source: Model Durmisevic 2006, 2018
© E.Durmisevic 2018

Reversible Building

Reuse Potential Tool

©Model Durmisevic 2015

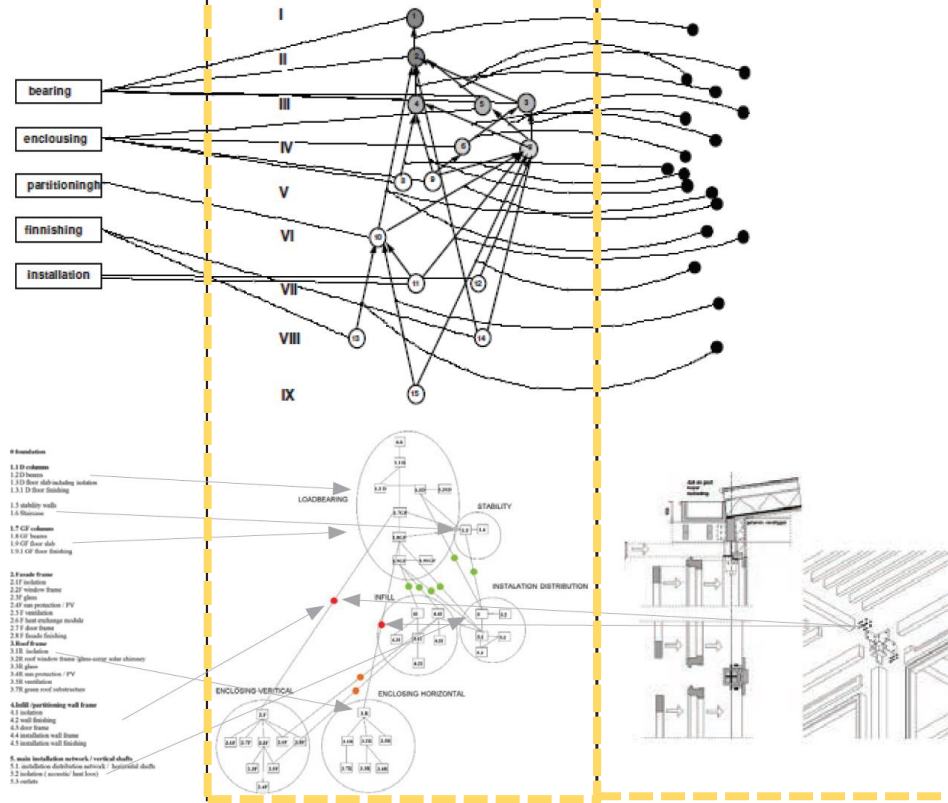


Technical Reversibility

Functional dependence

Technical dependence

Physical dependence



© Durmisevic 2009



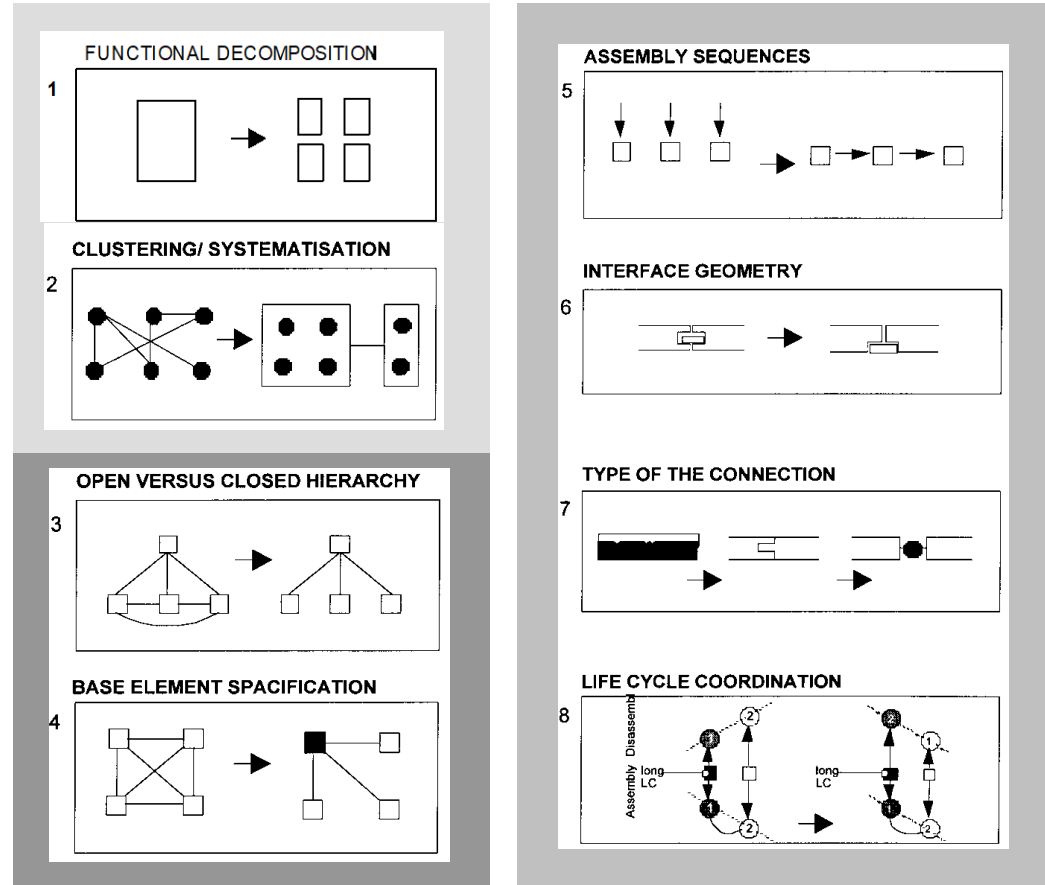
INDICATORS/ Technical Reversibility

8 ASPECTS OF TECHNICAL REVERSIBILITY

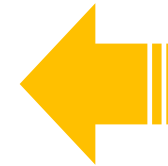
FUNCTIONAL
decomposition



TECHNICAL
dependences



PHYSICAL
dependences



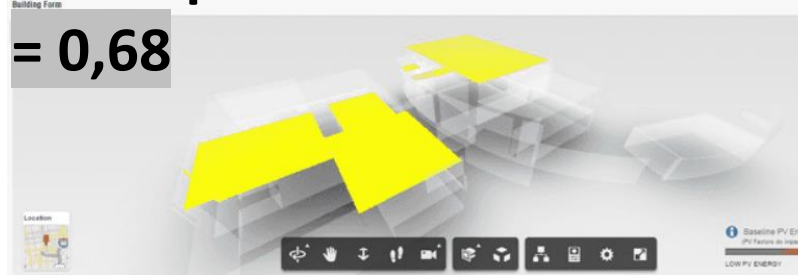
Reversible Building

Reuse Potential Tool- towards Reversible BIM

©Model Durmisevic 2015

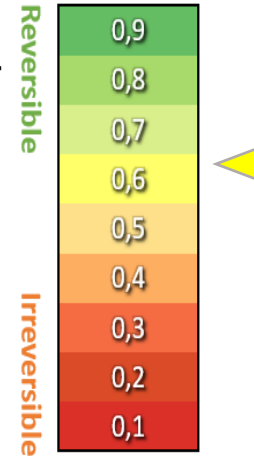
Reuse potential

= 0,68



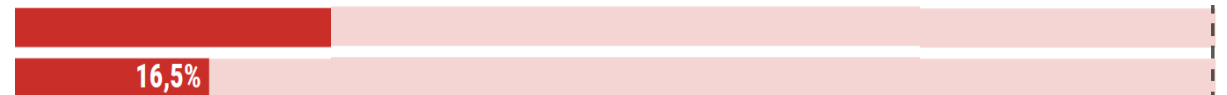
Reuse options:

- 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

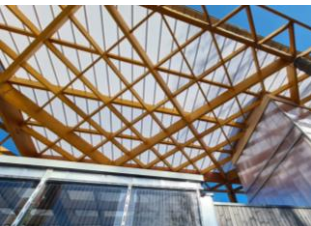


Exchangeability	Indicators	Criteria	RP Score per sub indicator			RP Score per indicator	Factors
			Bottom floor	Top floor	Average both levels		
Functional independence	Functional decomposition	F1 Functional separation	0,6	0,6	0,60	0,7	1
		F2 Functional integration	0,73		0,73		
Technical independence	Systematisation of material levels	S1 Number of material levels	0,9	0,9	0,90	0,75	2
		S2 Type cluster - clustered parts vs non-clustered parts	0,6	0,6	0,60		
	Relational pattern	R1 Number of relations	0,6	0,9	0,75	0,82	1
		R2 Hierarchical position of relations	0,9	0,9	0,90		
R3 Type of relational pattern - open vs closed pattern		0,8	0,8	0,80			
Physical independence	Assembly	A1 Assembly sequences	0,7	0,7	0,70	0,70	1
		B1 Type of base element	0,50	0,50	0,50		
	Life cycle coordination	L1 Technical life cycle coordination	0,90	0,90	0,90	0,85	1
		L2 Remaining Technical lifespan	0,81	0,79	0,80		
Physical independence	Connections	C1 type of connections	0,54	0,51	0,52	0,52	3
		AC1 Accessibility to fixing	0,70	0,69	0,69		
	Geometry	G1 Standardisation of product edge	0,84	0,84	0,84	0,82	1
G2 Geometry of product edge		0,80	0,80	0,80			
Dimension	Production Dimension	PD1 Standardisation to production dimensions	0,78	0,78	0,78	0,78	1
total score*						0,68	

Embodied Environmental Impact
Embodied Value (EV)



©Model Durmisevic 2009/2015



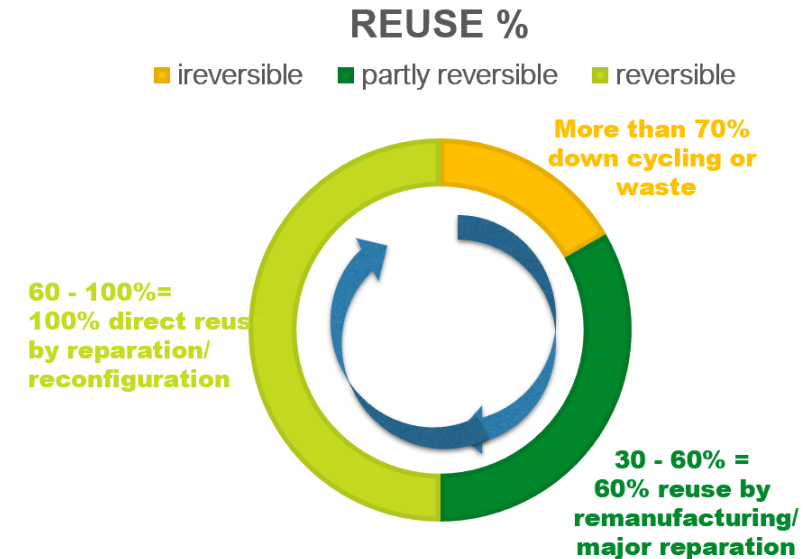
3 CATEGORIES OF MATERIAL STREAMS

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.**



Source: E.Durmisevic 2015

Reversible BIM

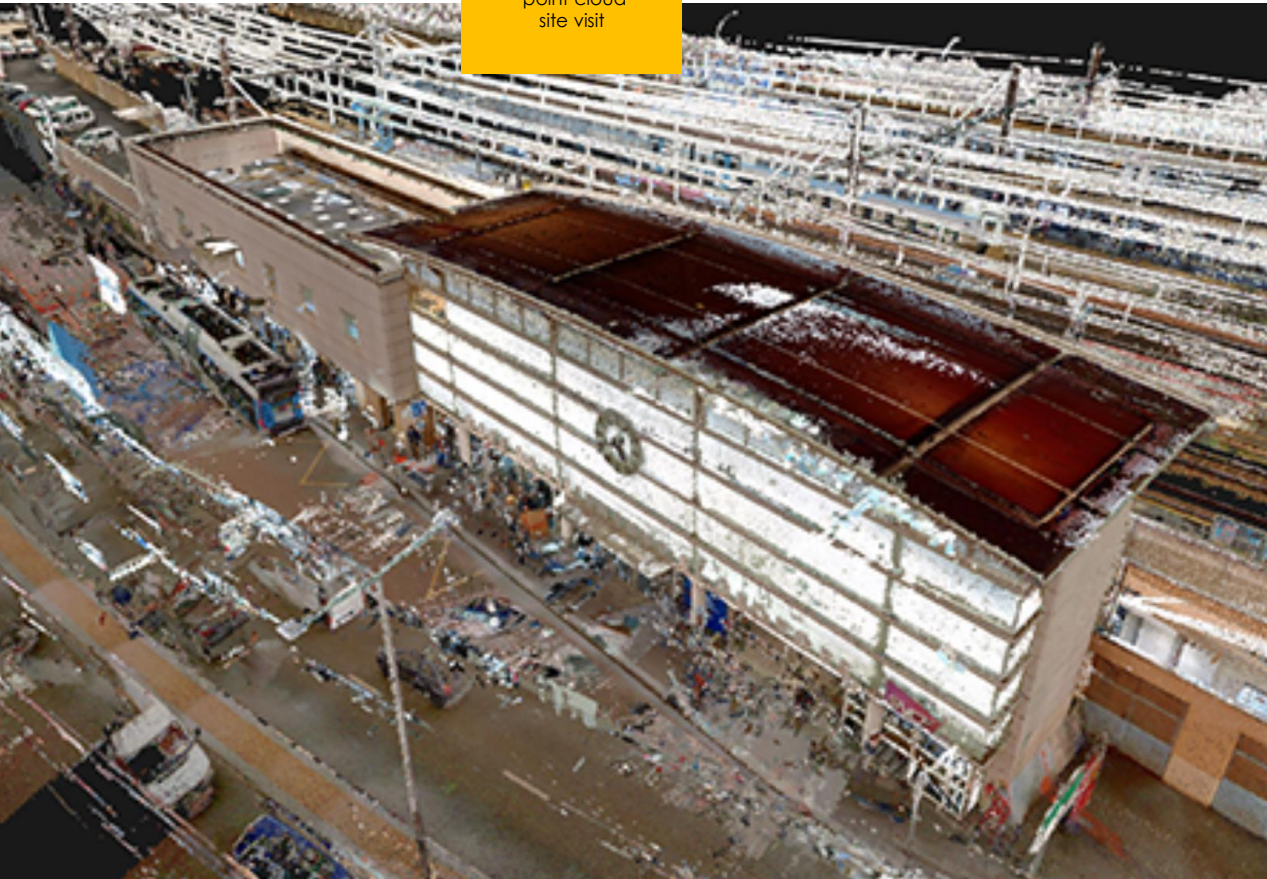
Reuse Potential Tool

©Model Durmisevic 2015/4D

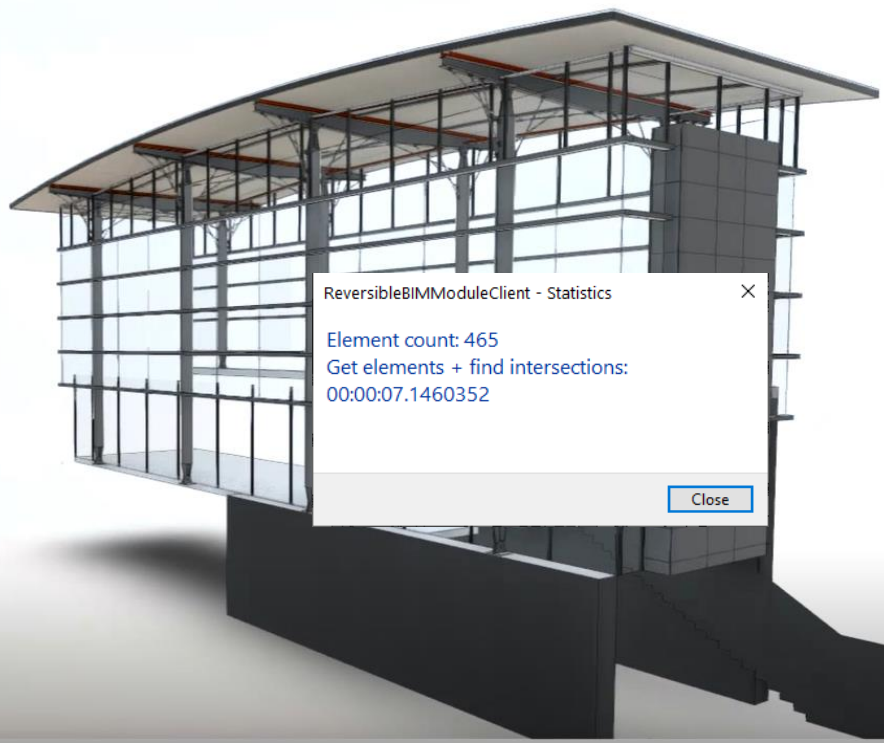


DATA GATHERING

Drawings
point cloud
site visit



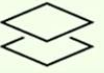
Comments Print Screenshot Share



ReversibleBIMModuleClient - Statistics

Element count: 465
Get elements + find intersections:
00:00:07.1460352

Close



REVERSIBLE BIM

Digital reversible 3D twin

Reversible
BIM

Reuse Potential
Tool

©Model Durmisevic 2015/4D

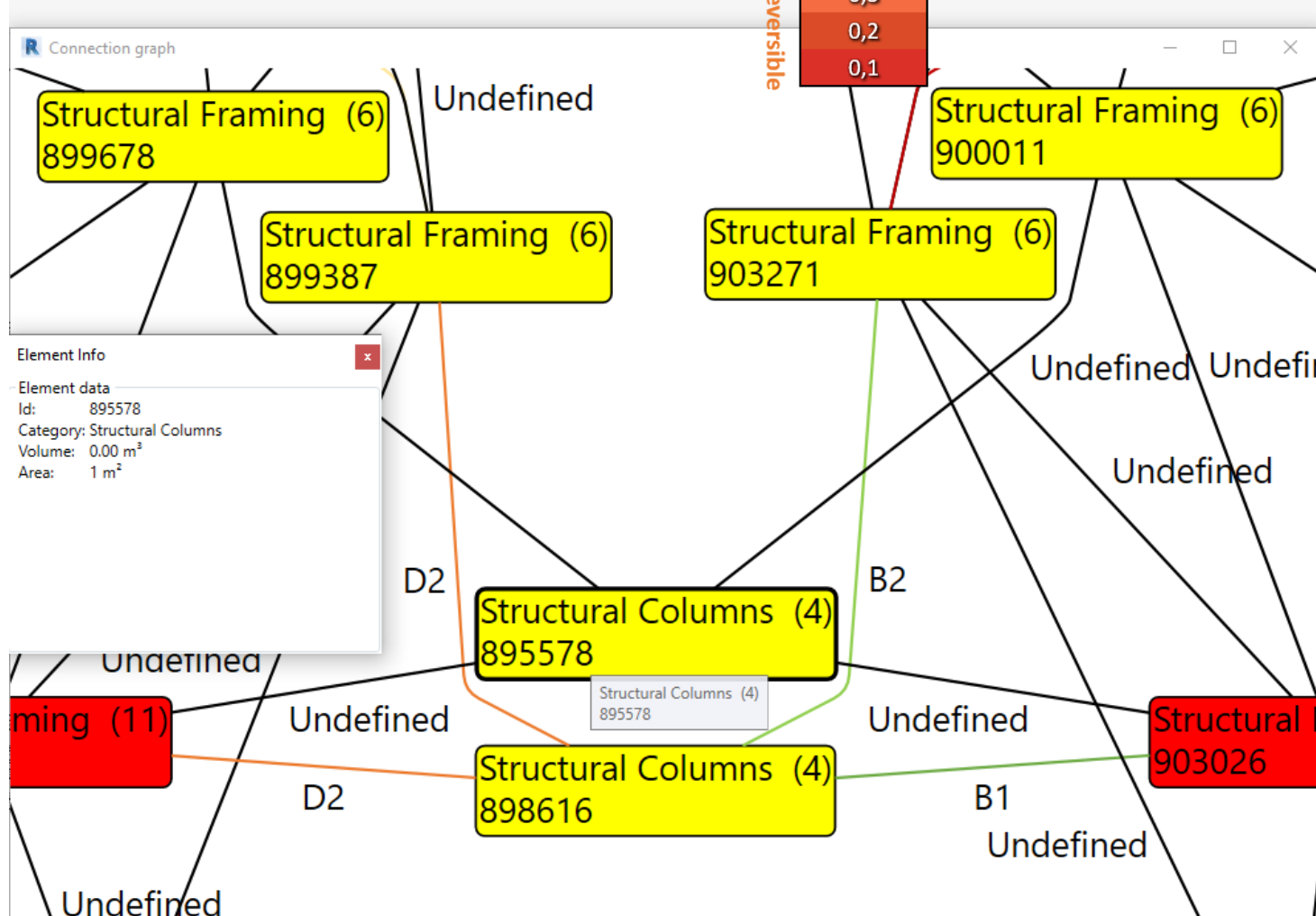


5

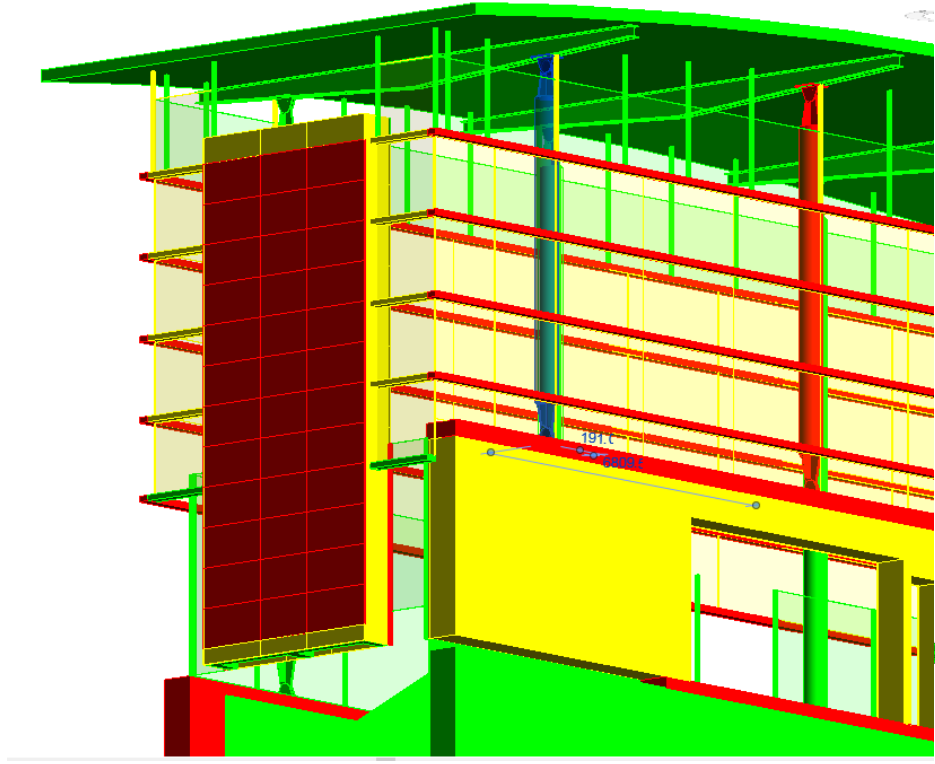
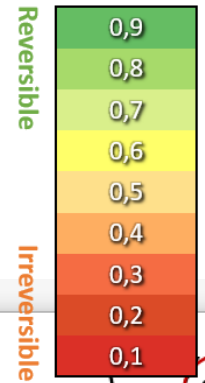
Colour coded diagram representing relational dependences between elements

Element connections

Element ID	Connection type
891148	D2
899387	D2
903026	B1
903271	B2



BUILDING
REUSE POTENTIAL

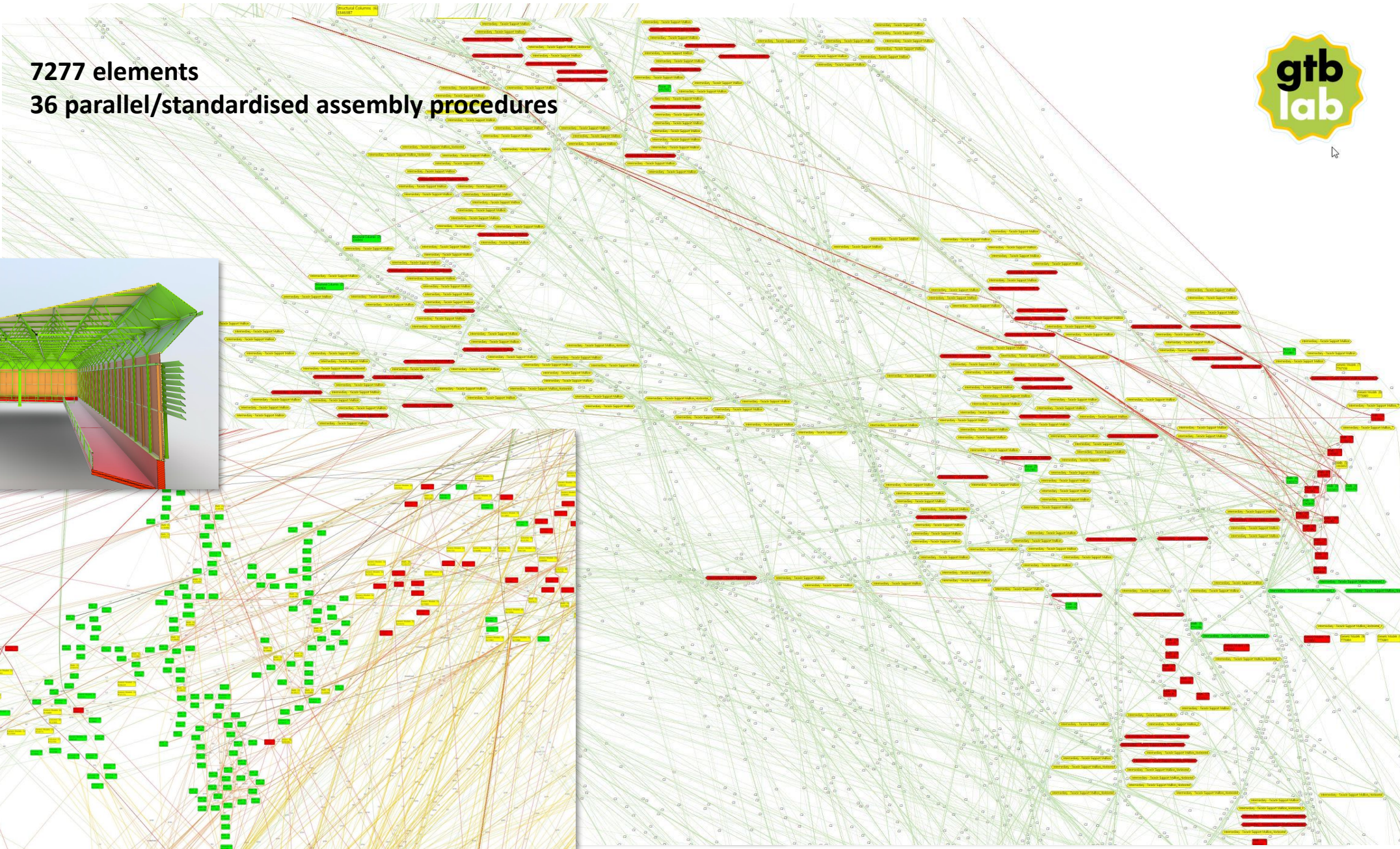


Reversible BIM

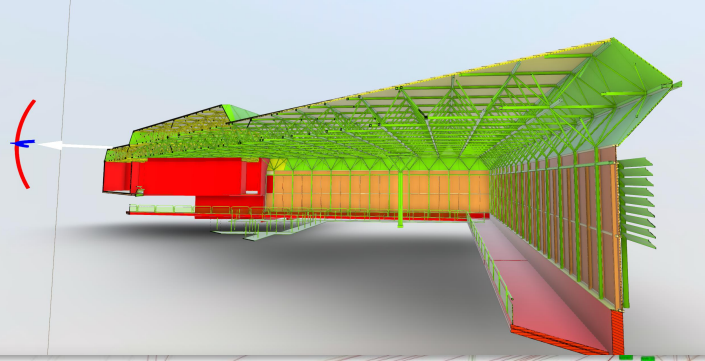
Reuse Potential Tool

©Model Durmisevic 2015

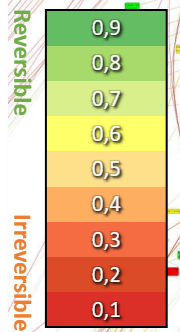
4D architects



7277 elements
36 parallel/standardised assembly procedures



BUILDING REUSE POTENTIAL



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

Reversible BIM

Reuse Potential Tool

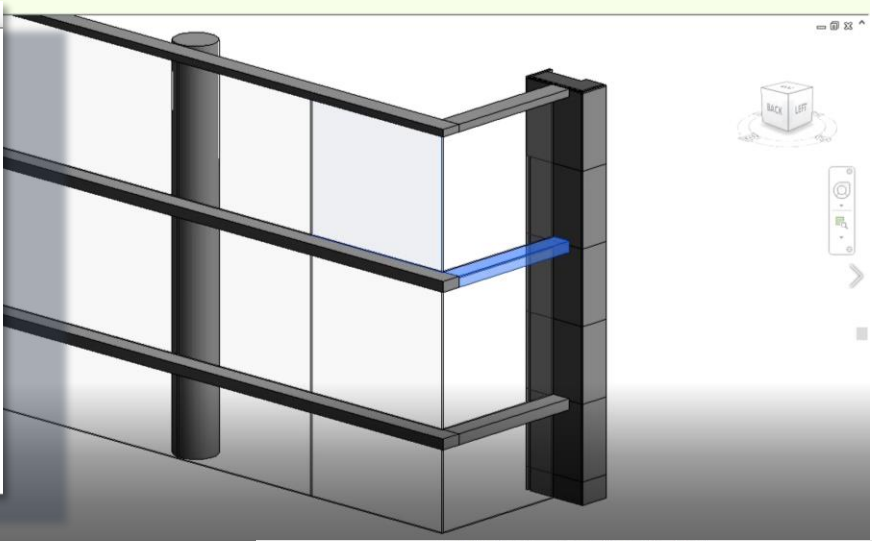
©Model Durmisevic 2015/4D

Element connections

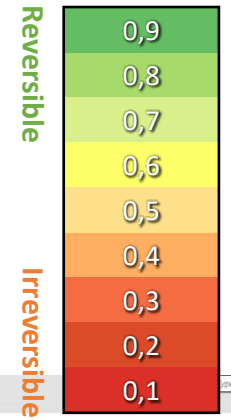
Element data

Id: 898616
 Category: Columns
 Volume: 0.71 m³
 Area: 5 m²
 Connections: 4

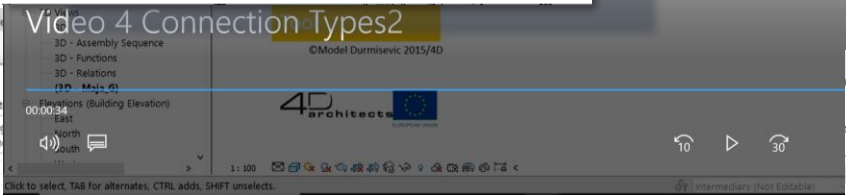
Element ID	Connection type
891148	D2
899387	D2
903026	B1
903271	B2



BUILDING REUSE POTENTIAL



- Connect elements
- Reversible connections
 - Gravity connection
 - A1 (Gravitational force 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 (rivet))
 - Direct chemical connection
 - Indirect connection with reversible chemical connection
 - D1 (Material weaker than connected part (glue, tape))
 - D2 (Covering material, weaker than connected part (paint, plaster, screed))
 - Indirect connection with irreversible chemical connection
 - D3 (Material stronger than connected part (cement))
 - Direct chemical connection
 - D4 (Covering material, stronger than connected part (in-situ concrete))



Connect elements

Selected elements

Category: Doors
 Element ID: 286882

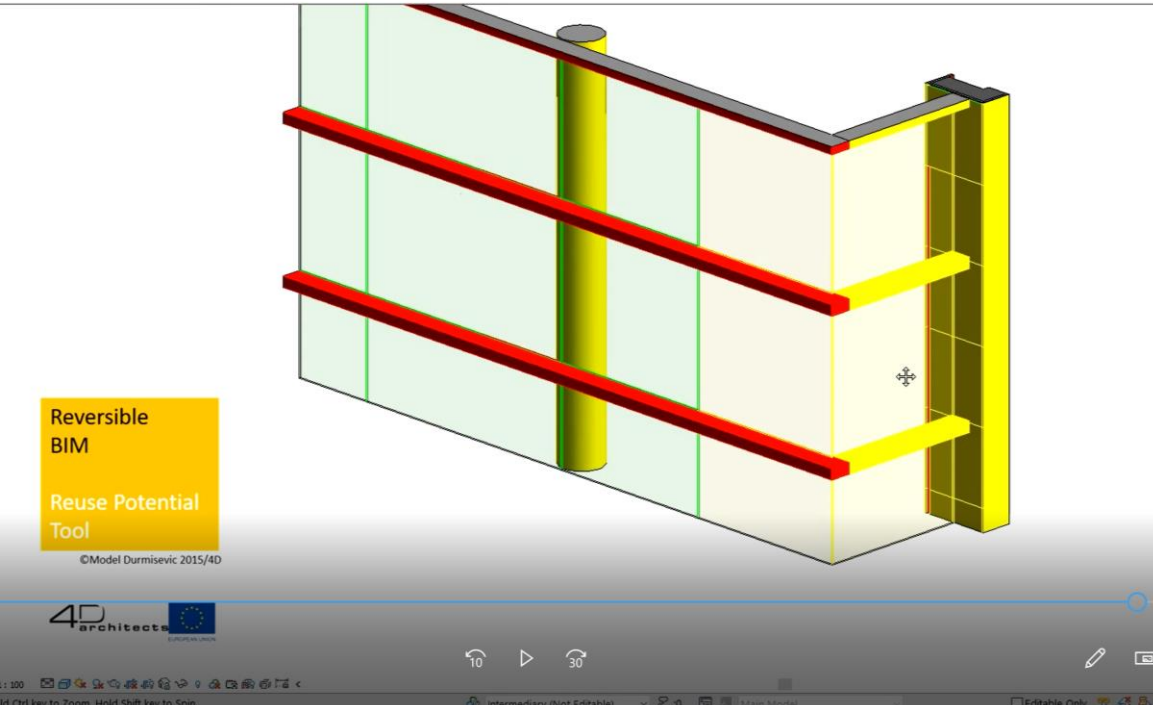
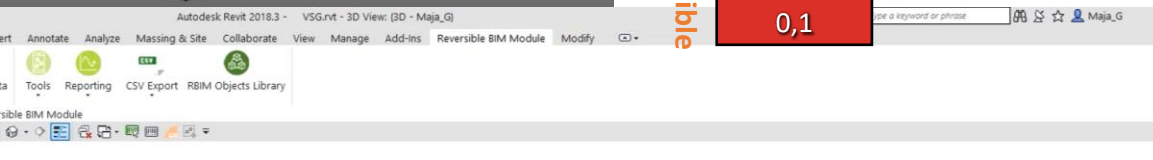
Category: Doors
 Element ID: 286910

- Direct chemical connection
 - Indirect connection with irreversible chemical connection
 - D1 (Material weaker than connected part (glue, tape))
 - D2 (Covering material, weaker than connected part)



ViewBIMModuleDataDialog

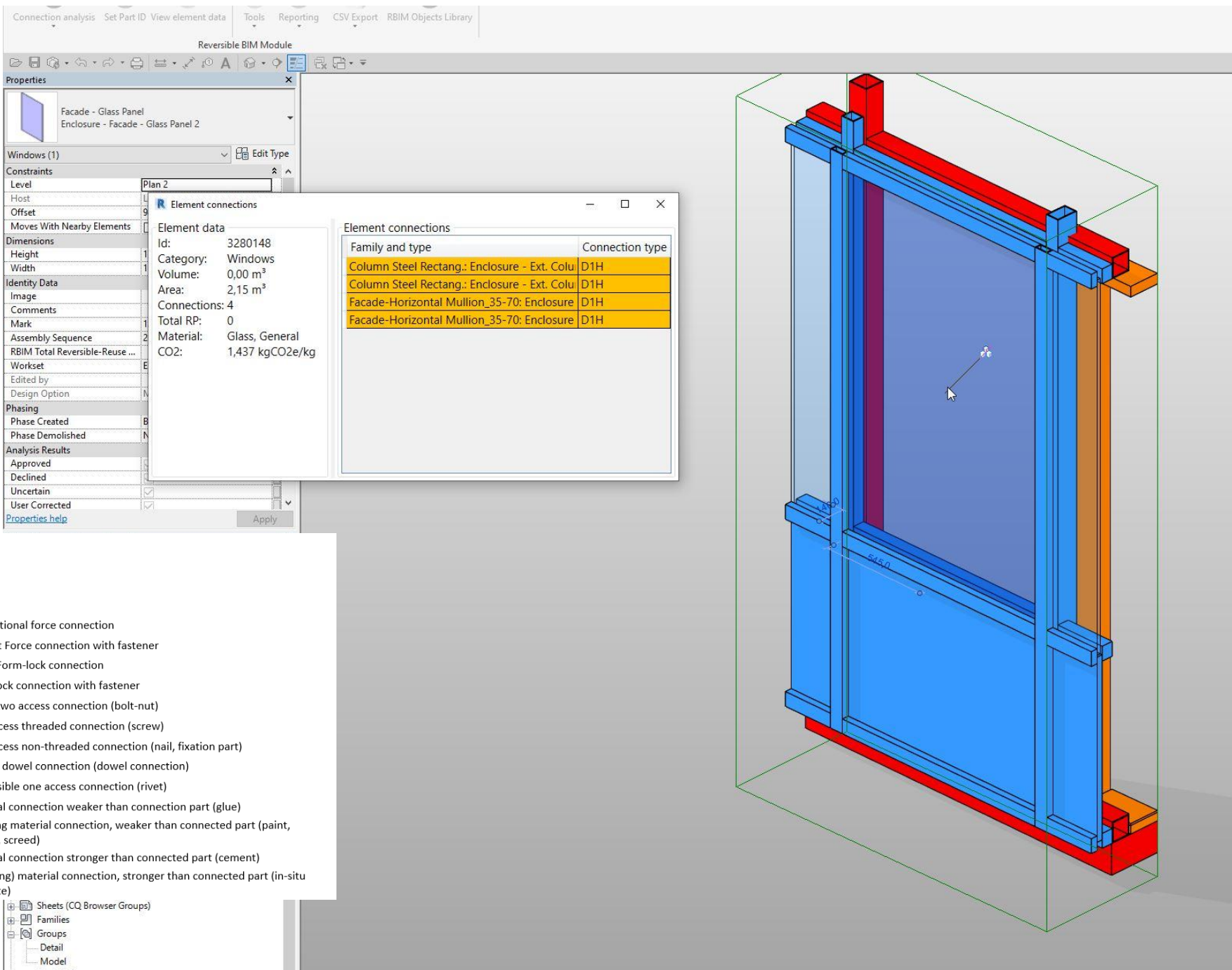
Element: 286882, Connection type: A2
 Element: 286910, Connection type: C3



Reversible BIM

Reuse Potential Tool

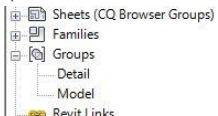
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INDICATOR 4

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

©Model Durmisevic 2015

4D
architects



Glass Facade [28360...

Glass Facade [28564...

Glass Facade [28581...

Glass Facade [28667...

▶ Profile Facade

▶ Panel Vent.Facade

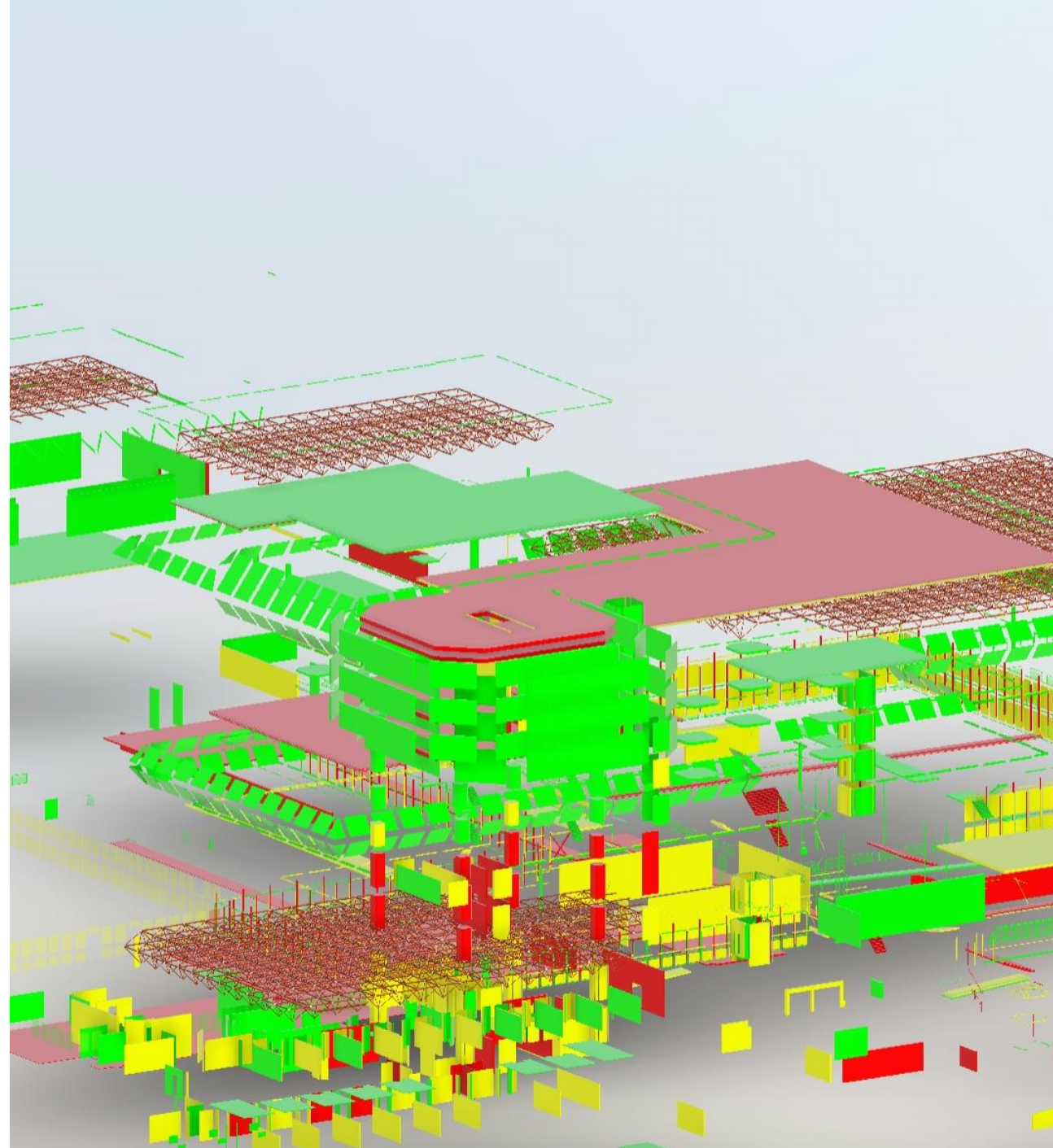
▼ Floors

▼ Floor

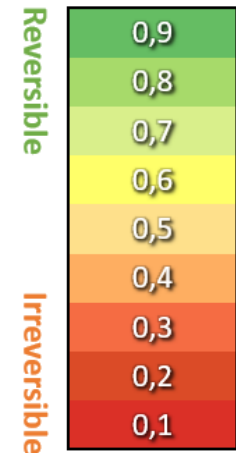
▼ Floor Slab 200 mm

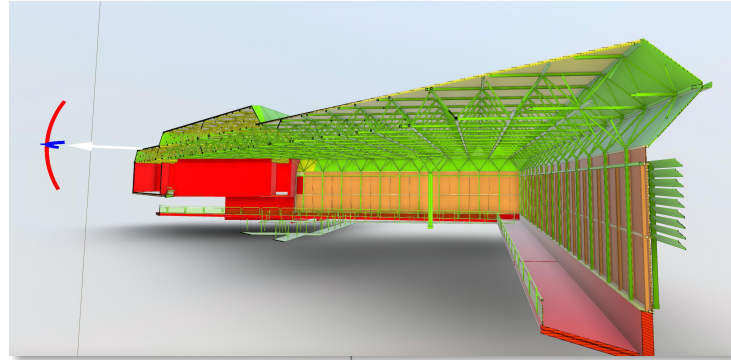
Floor [280579]

▶ Roofs



BUILDING REUSE POTENTIAL





Information for inventory expert

Element sheet

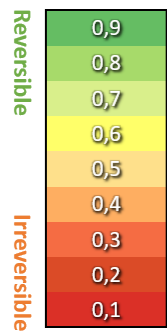
total ton embodied CO2 = 6070 ton CO2

Avoided CO2 = 3202 ton CO2 total reused material = 567 m3



Sequence no.	ID	Type	level	Element function	Material name	Embodied car.	Volume	Area	Numbe	Total RP	Reused carbon(kg)	Reused material (m³)	function	Material gro	material (ton)	Reused material (ton)
7230	35	3277732	Plan 2	Finishing	Plaster, Dried clay plaster	28,60431316	0,182495	12,16635	2	0,45	12,87194092	0,082122885	3. Partitioning	Plaster	0,310242008	0,139608904
7231	35	2131406	Plan 2	Finishing	Plaster, Dried clay plaster	15,23674247	0,09721	6,480687	5	0,45	6,856534111	0,043744635	3. Partitioning	Plaster	0,165257511	0,07436588
7232	35	2131386	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	39,11559335	0,03582	2,388009	3	0,45	17,60201701	0,016119063	3. Partitioning	Ceramics	0,050148197	0,022566688
7233	35	2144659	Plan 2	Finishing	Plaster, Dried clay plaster	18,28198503	0,116639	7,775928	4	0,45	8,226893266	0,052487516	3. Partitioning	Plaster	0,198286172	0,089228777
7234	35	2122041	Plan 3	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	14,54497334	0,01332	0,936422	3	0,45	6,545238003	0,005993808	3. Partitioning	Ceramics	0,018647402	0,008391331
7235	35	2144658	Plan 2	Finishing	Plaster, Dried clay plaster	6,345435075	0,040484	2,719172	4	0,45	2,855445784	0,018217722	3. Partitioning	Plaster	0,068822506	0,030970128
7236	35	2131814	Plan 2	Finishing	Plaster, Dried clay plaster	5,670187168	0,036176	2,411717	5	0,45	2,551584226	0,016279088	3. Partitioning	Plaster	0,061498776	0,027674449
7237	35	2131723	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	26,80048869	0,024543	1,636171	3	0,45	12,06021991	0,011044157	3. Partitioning	Ceramics	0,034359601	0,01546182
7238	35	2131902	Plan 2	Finishing	Plaster, Dried clay plaster	4,387454736	0,027992	1,866129	4	0,45	1,974354631	0,012596367	3. Partitioning	Plaster	0,047586277	0,021413825
7239	35	2131922	Plan 2	Finishing	Plaster, Dried clay plaster	6,720716482	0,042878	2,858541	5	0,45	3,024322417	0,019295154	3. Partitioning	Plaster	0,072892803	0,032801762
7240	35	2131626	Plan 2	Finishing	Plaster, Dried clay plaster	15,03713408	0,095937	6,395787	4	0,45	6,766710335	0,04317156	3. Partitioning	Plaster	0,163092561	0,073391652
7241	35	2144661	Plan 2	Finishing	Plaster, Dried clay plaster	4,71772926	0,030099	2,046651	4	0,45	2,122978167	0,013544584	3. Partitioning	Plaster	0,05116843	0,023025794
7242	35	2131582	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	73,17831565	0,067013	4,467541	3	0,45	32,93024204	0,030155895	3. Partitioning	Ceramics	0,093818353	0,042218259
7243	35	2144662	Plan 2	Finishing	Plaster, Dried clay plaster	6,580535686	0,042012	2,840878	5	0,45	2,963266059	0,018905615	3. Partitioning	Plaster	0,071421211	0,032139545
7244	35	3277731	Plan 2	Finishing	Plaster, Dried clay plaster	28,60431316	0,182495	12,16635	2	0,45	12,87194092	0,082122885	3. Partitioning	Plaster	0,310242008	0,139608904
7245	35	2130270	Plan 2	Finishing	Plaster, Dried clay plaster	13,32662258	0,085024	5,66825	4	0,45	5,996980159	0,038260688	3. Partitioning	Plaster	0,144540375	0,065043169
7246	35	2144660	Plan 2	Finishing	Plaster, Dried clay plaster	12,49941745	0,079746	5,336663	3	0,45	5,624737851	0,035885784	3. Partitioning	Plaster	0,135568519	0,061005834
7247	35	2131263	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	39,64214516	0,036302	2,420155	3	0,45	17,83896532	0,016336049	3. Partitioning	Ceramics	0,050823263	0,022870468
7248	35	2131197	Plan 2	Finishing	Plaster, Dried clay plaster	8,291456286	0,052899	3,526629	4	0,45	3,73155329	0,023804742	3. Partitioning	Plaster	0,089929027	0,040468062
7249	35	2131131	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	39,50871489	0,03618	2,412009	3	0,45	17,7789217	0,036281064	3. Partitioning	Ceramics	0,050652199	0,022793489
7250	35	2131018	Plan 2	Finishing	Ceramics, Tiles and Cladding Panels (chemical connection)	38,89884485	0,035622	2,374777	3	0,45	17,50448018	0,016029744	3. Partitioning	Ceramics	0,049870314	0,022441641
7251	36	4267324	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	244,9267757	0,785022	15,70043	1	0,9	220,4340981	0,706519545	3. Partitioning	Plaster	0,628017373	0,565215636
7252	36	8199477	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	123,5005767	0,395835	7,916704	1	0,9	111,150519	0,356251664	3. Partitioning	Plaster	0,316668145	0,285001331
7253	36	8200234	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	228,1772335	0,731337	14,62675	1	0,9	205,3595101	0,658203558	3. Partitioning	Plaster	0,585069829	0,526562846
7254	36	8200470	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	178,7982893	0,573071	11,46143	1	0,9	160,9184604	0,51764296	3. Partitioning	Plaster	0,458457152	0,412611437
7255	36	4268946	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	244,9637073	0,78514	15,7028	1	0,9	220,4673366	0,706626079	3. Partitioning	Plaster	0,62811207	0,565300863
7256	36	4268998	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,7244212	0,781168	15,62336	1	0,9	219,351979	0,703051215	3. Partitioning	Plaster	0,624934413	0,562440972
7257	36	2150136	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	82,77593338	0,265307	5,20316	1	0,9	74,49834004	0,238776731	3. Partitioning	Plaster	0,212245983	0,191021385
7258	36	4268620	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,4810434	0,780388	15,60776	1	0,9	219,1329391	0,702349164	3. Partitioning	Plaster	0,624310368	0,561879331
7259	36	8221174	Plan 2	Partitioning	Timber, Particle Board	-33,49778445	0,059841	2,992051	1	0,9	-30,148006	0,05385692	3. Partitioning	Timber	0,041101576	0,036991418
7260	36	8199455	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	285,3403899	0,914553	18,29105	1	0,9	256,8063509	0,823097279	3. Partitioning	Plaster	0,731642025	0,658477423
7261	36	8375564	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	82,97163619	0,265935	5,318695	1	0,9	74,67447257	0,239341258	3. Partitioning	Plaster	0,212747785	0,191473007
7262	36	8375471	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	100,4168948	0,321849	6,43698	1	0,9	90,37520532	0,28966412	3. Partitioning	Plaster	0,257479217	0,231731296
7263	36	8376201	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	963,4187964	3,087881	61,75762	1	0,9	867,0769168	2,779092682	3. Partitioning	Plaster	2,470304606	2,223274146
7264	36	8376099	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	1353,354326	4,337674	86,75348	1	0,9	1218,018893	3,903906708	3. Partitioning	Plaster	3,470139296	3,123125367
7265	36	4266273	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	241,7661824	0,774892	15,49783	1	0,9	217,5895642	0,697402445	3. Partitioning	Plaster	0,619913288	0,557921958
7266	36	4435363	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	397,7691032	1,274901	25,49802	1	0,9	357,9921929	1,147410875	3. Partitioning	Plaster	1,019920777	0,9179287
7267	36	2112436	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	336,4103531	1,078238	21,56477	1	0,9	302,7693178	0,97041448	3. Partitioning	Plaster	0,862590649	0,776331584
7268	36	2118883	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	243,4849586	0,780401	15,60801	1	0,9	219,1364628	0,702360458	3. Partitioning	Plaster	0,624320407	0,561888366
7269	36	8376482	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	73,0322585	0,234078	4,681555	1	0,9	65,72903265	0,21066997	3. Partitioning	Plaster	0,187262201	0,168535981
7270	36	8376900	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	13,96318722	0,044754	0,895076	1	0,9	12,5668685	0,040278425	3. Partitioning	Plaster	0,035803044	0,03222274
7271	36	8376857	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	73,11648333	0,234348	4,686954	1	0,9	65,804835	0,210912935	3. Partitioning	Plaster	0,187478162	0,168730346
7272	36	8222906	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	231,8518278	0,743115	14,8623	1	0,9	208,666645	0,668803349	3. Partitioning	Plaster	0,594491866	0,53504268
7273	36	8376943	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	20,46459794	0,065592	1,311833	1	0,9	18,41813815	0,052473328	3. Partitioning	Plaster	0,047225995	0,042725995
7274	36	8376696	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	14,30657094	0,045854	0,917088	1	0,9	12,87591385	0,041268955	3. Partitioning	Plaster	0,036683515	0,033015164
7275	36	8376621	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	21,19006988	0,067917	1,358338	1	0,9	19,07106289	0,061125202	3. Partitioning	Plaster	0,054335313	0,048900161
7276	36	8376814	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	72,65372028	0,232864	4,65729	1	0,9	65,38834825	0,209578039	3. Partitioning	Plaster	0,18629159	0,167662431
7277	36	8376752	Plan 2	Partitioning	Plaster, Plasterboard (ceiling tiles)	28,24707972	0,090536	1,81071	1	0,9	25,42237175	0,081481961	3. Partitioning	Plaster	0,07242841	0,065185565

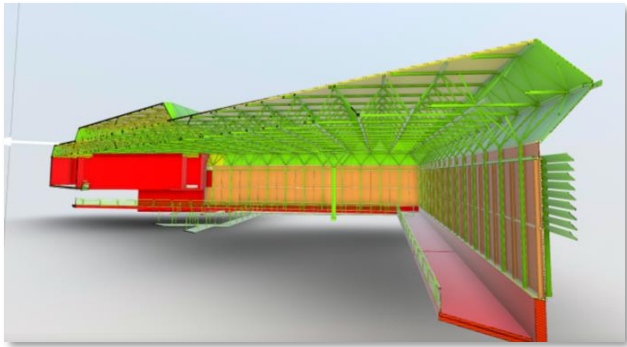
BUILDING
REUSE POT



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

Reversible BIM
Reuse Potential Tool

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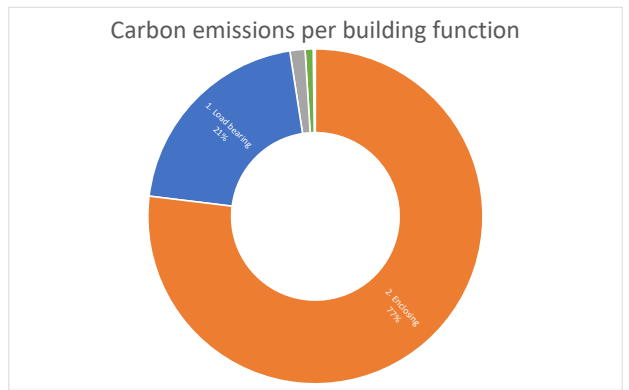
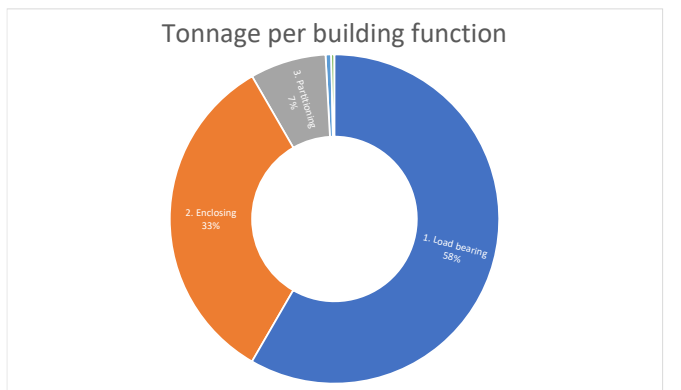
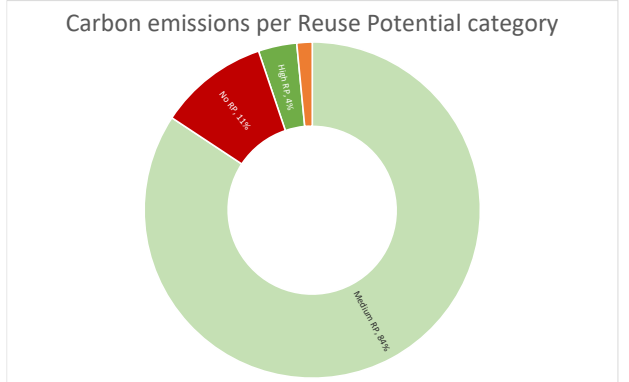
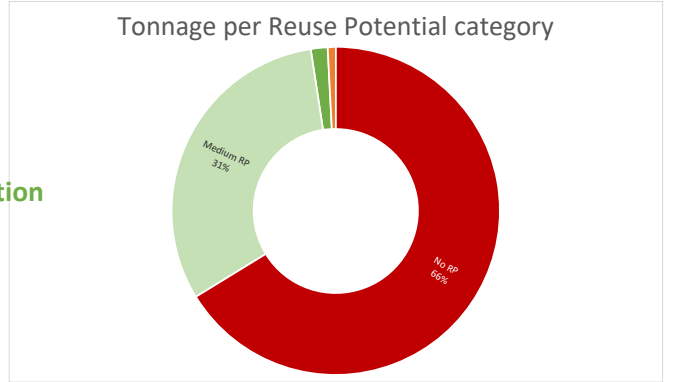
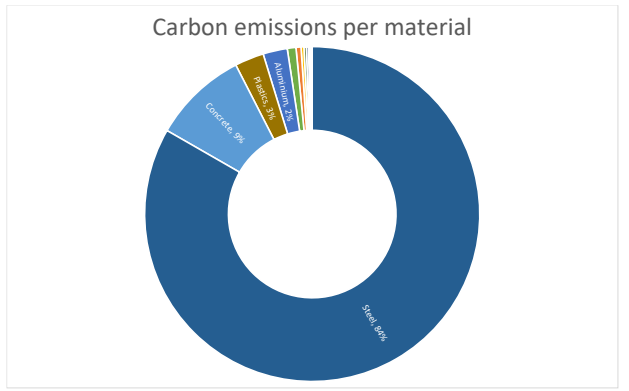
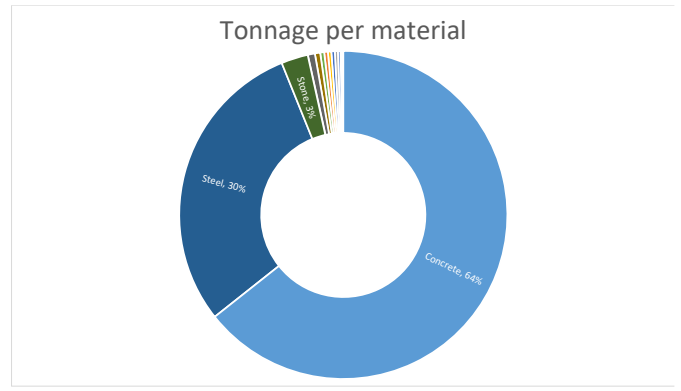
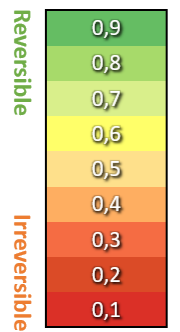
Direct reuse
2231 ton

Reus by reparation
2150 ton

Recycled
2000 ton

Avoided CO2 ton
3000 ton

BUILDING REUSE POTENTIAL



Reversible BIM

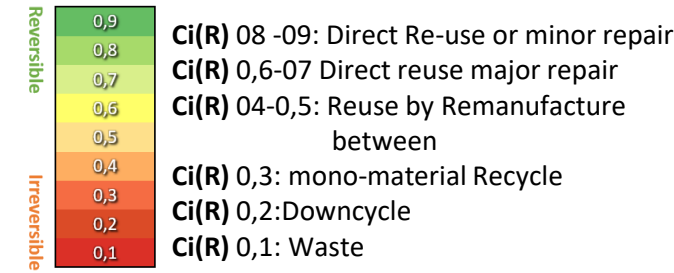
Reuse Potential Tool

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

Tonnages and reuse options

BUILDING REUSE POTENTIAL



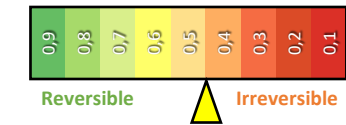
Reused tonnage per material (ton)

	Aluminium	Asbestos	Bitumen	Ceramics	Concrete	Glass	Insulation	Linoleum	Plaster	Plastics	Steel	Stone	Timber	Total	Proportion
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 (0,2-0,3)	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%	

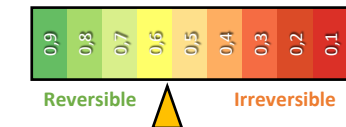
Reused tonnage per function (ton)

	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 (0,2-0,3)	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



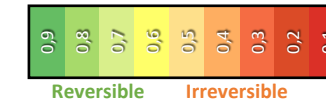
Waste produced



RP/Circularity Indicator



Recycling tonnage

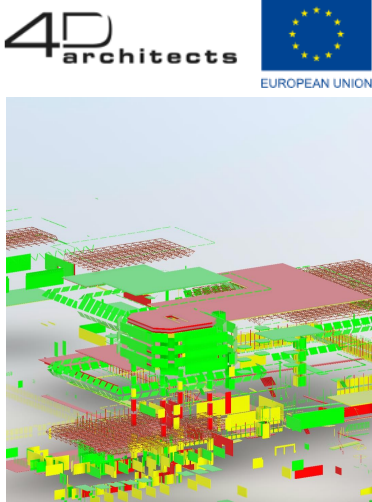
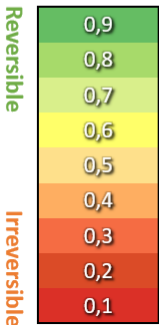


Volume reused

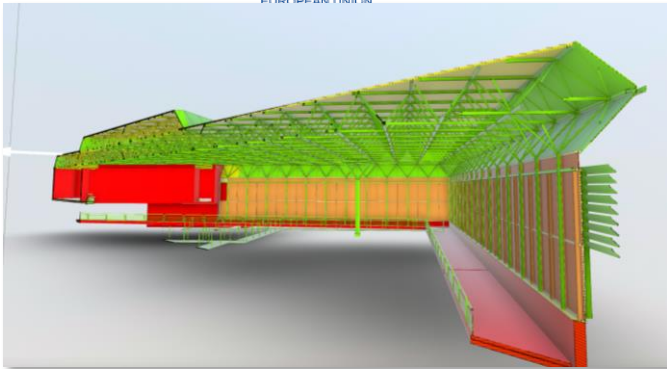


Focus points
Per function
Per material
%

BUILDING REUSE POTENTIAL

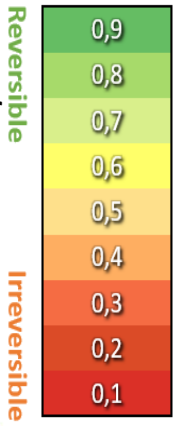


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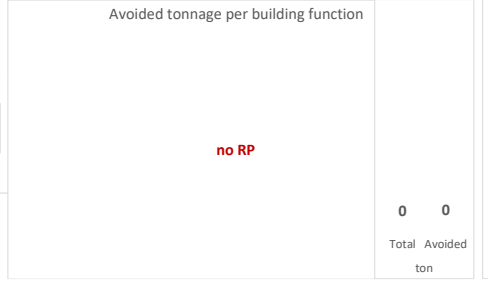
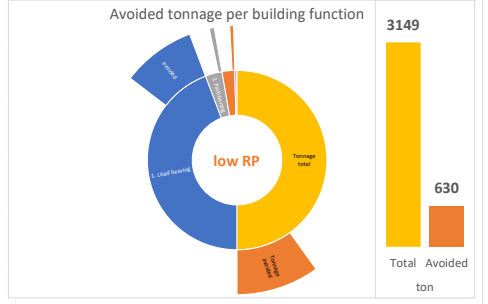
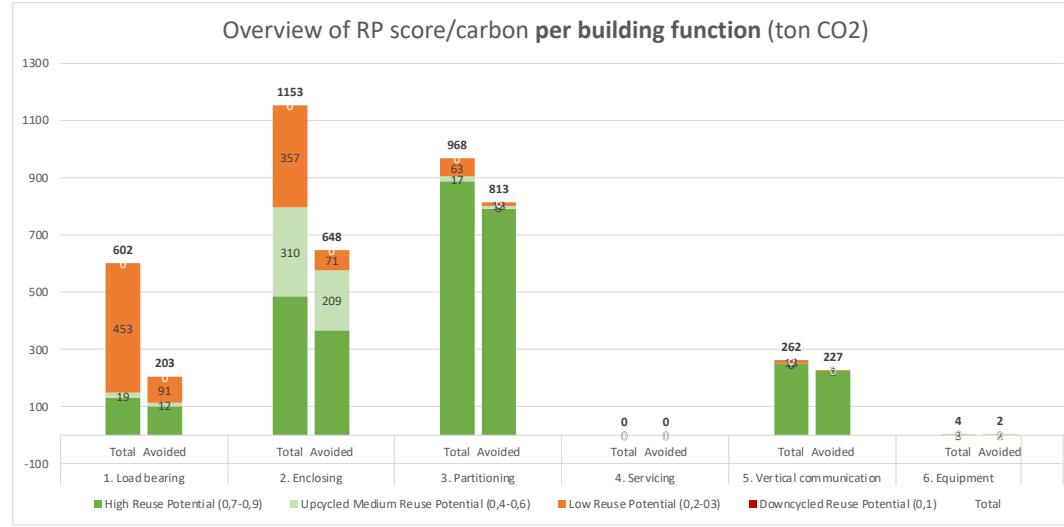
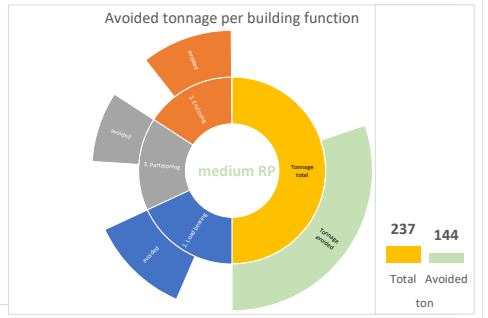
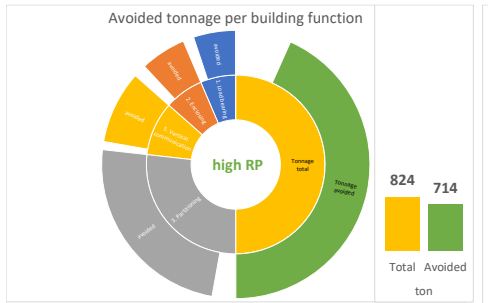
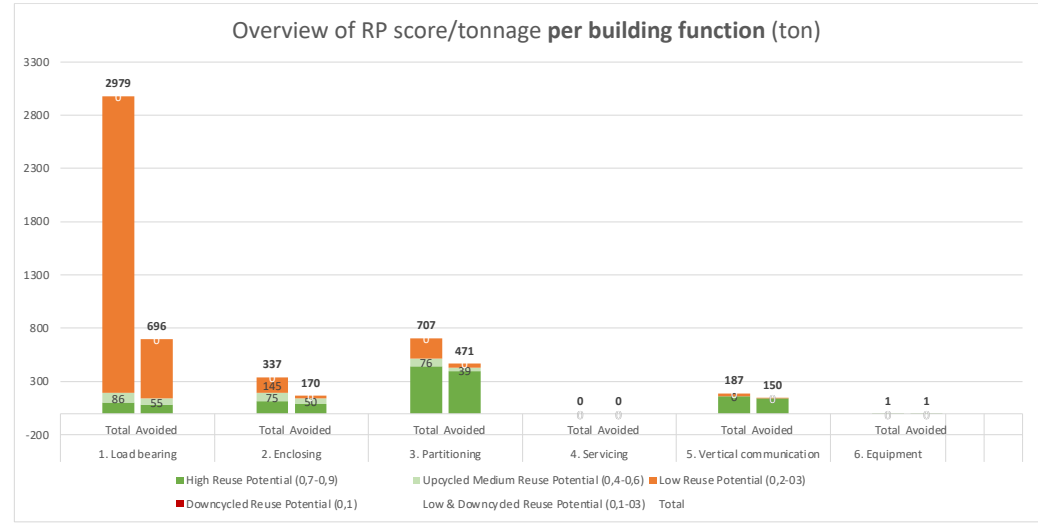


Reuse options:

- 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

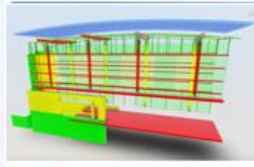


Avoided tonnages and CO2 per reuse option



Reversible BIM Projects | Reuse Potential

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

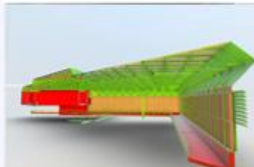


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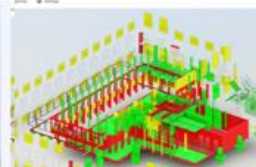


Roman Museum The Netherlands

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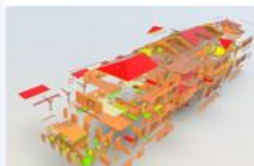


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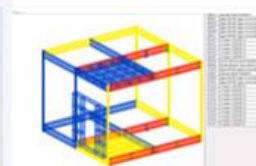


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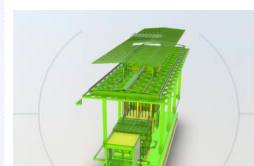


Reversible Module Heerlen

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Reversible/Green Building

NEWS

Circulair project



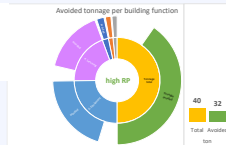
Reversible BIM

VILOGIA

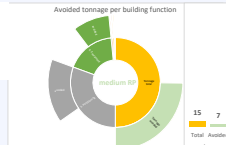
Delete Edit

Description 3d View

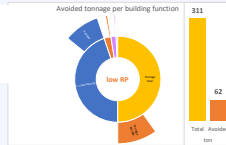
11% direct reuse



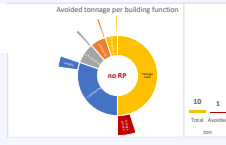
4% reuse by reparation



83% recycling



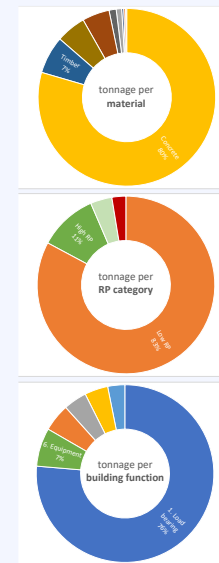
2% waste



Final output.rvt [Download](#)

REUSE POTENTIAL

- Reversible Building
Circularity profile 0
- Reversible Building
Circularity profile 1
- Reversible Building
Circularity profile 2
- Reversible Building
Circularity profile 3
- Reversible Building
Circularity profile 4



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RECRUITMENT



4D RESEARCH



YOUTUBE



INSTAGRAM



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LABORATORY FOR GREEN TRANSFORMABLE BUILDINGS

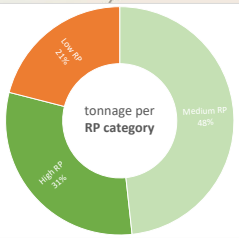


REVERSIBLE BIM

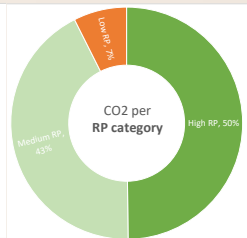
Digital inventory of reus potential

©E.Durmisevic 2019 *4D architects

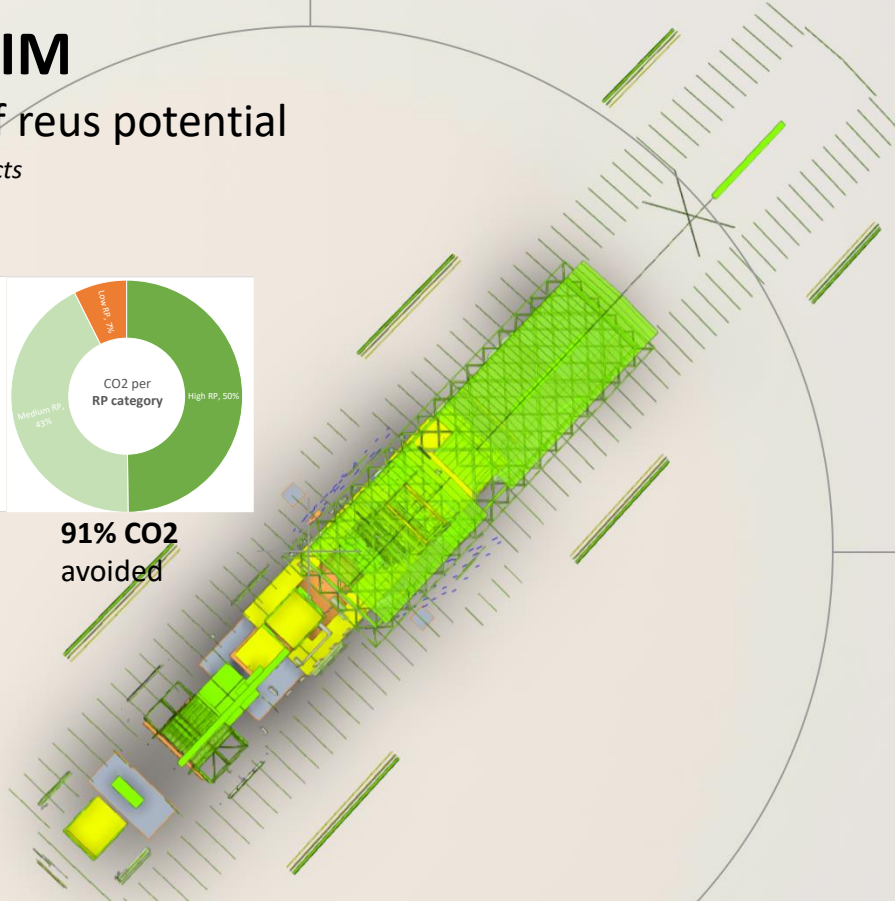
Circular ladder



79% Mateial reuse



91% CO2 avoided



Reversible
Irreversible



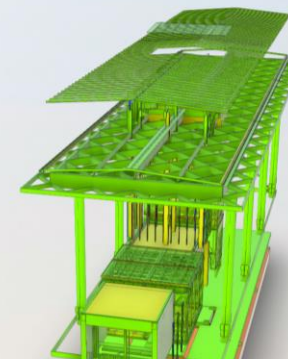
- 07-09: Re-use by minor repair
- 05-0,6: Reuse by major repair
- 04 Remanufacture
- 03 Mono-material
- 0,4 Recycle
- 02 Downcycle
- 01 Waste

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Reversible BIM

Reuse Potential Tool

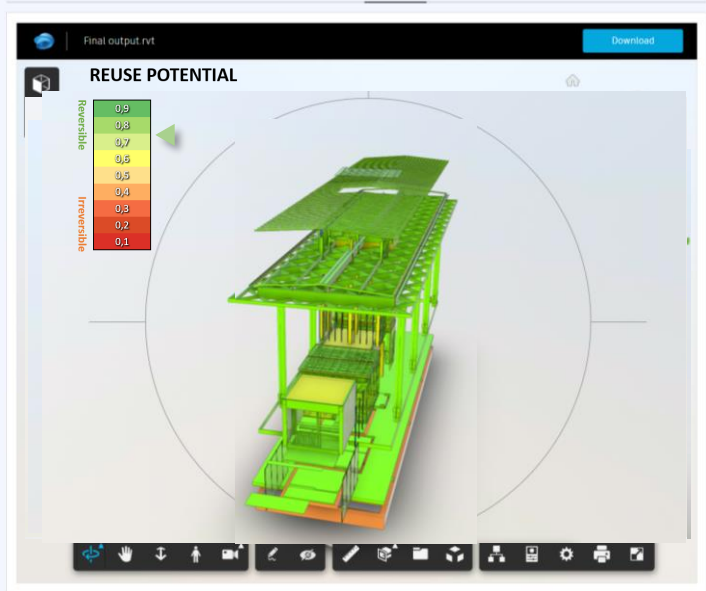
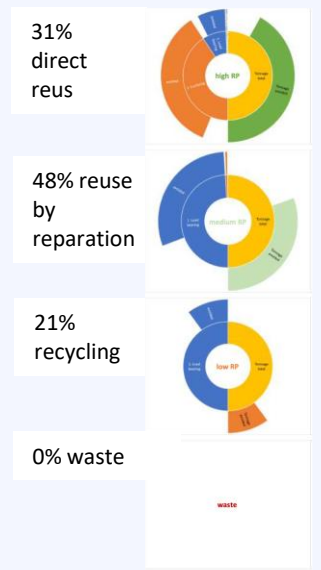
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Reversible BIM

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Circular Building Knowledge Platform

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Categories



Guidelines

Circular Building Design

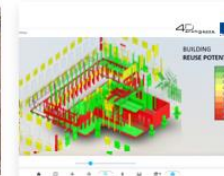
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Policy

Circular building

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Toolkits

Measuring circularity

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circular building projects

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Circular building materials

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Over GTB Lab

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**Circularity meter / index**

Partners

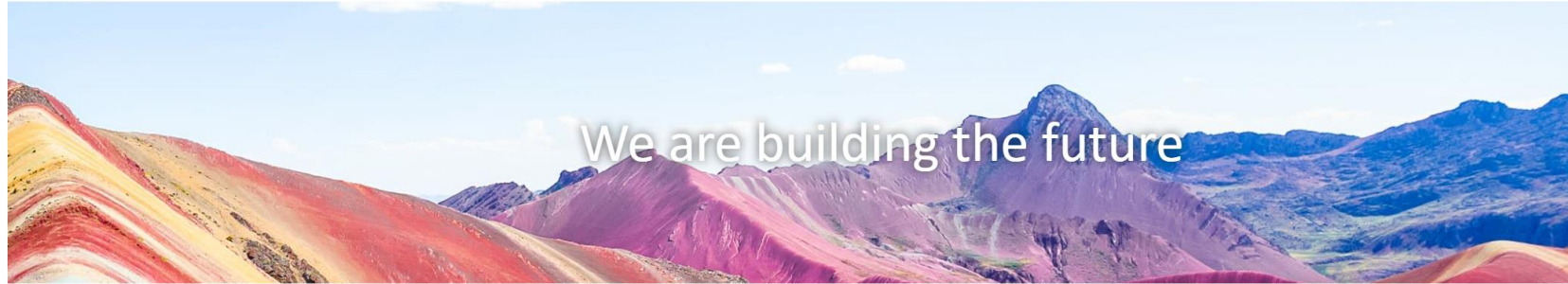


News

**Circular Building Infrastructure**

GTB Lab Blog

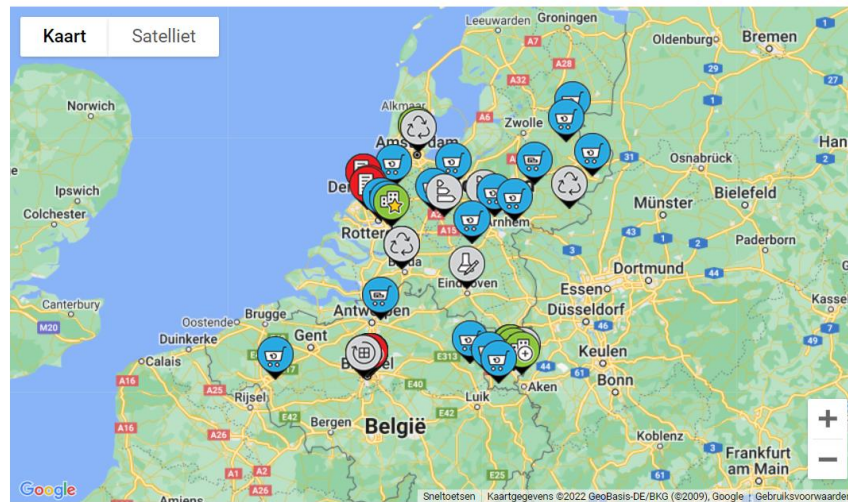




Home > Circular building mapping

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
 - Guidelines
 - Toolkits
- Type of building transformation:
- City:
- Radius:



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.



Circularity meter / index

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 raw 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 raw 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/bathroom 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 raw 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 <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										
					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 <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



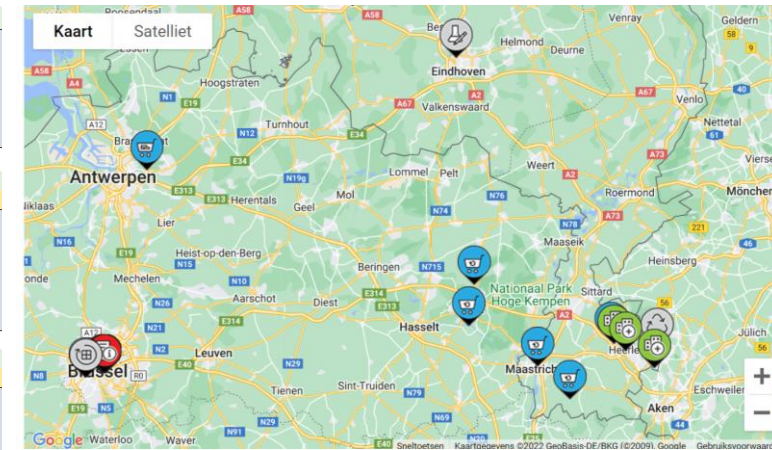
Home > Circular building mapping

Circular building mapping

Outstanding projects
 New construction projects
 Planned construction projects
 Transformation projects
 Policies
 Guidelines
 Toolkits

Refurbishment hubs
 Material recycling
 Certification labs
 Design & Living labs
 Type of building transformation
 Make a choice

Circular building products
 Materials
 City
 Amsterdam
 Radius
 Make a choice



Summary of selected markers

Number of projects	5
Gross floor area	13178 m2
Gross building volume	52608 m3

Materials

Tonnage total property (total)	0 ton
Tonnage total property (average)	0 ton
Tonnage reuseable 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 >](#)

News

Outstanding Projects:



News:



GTB Lab Construction:

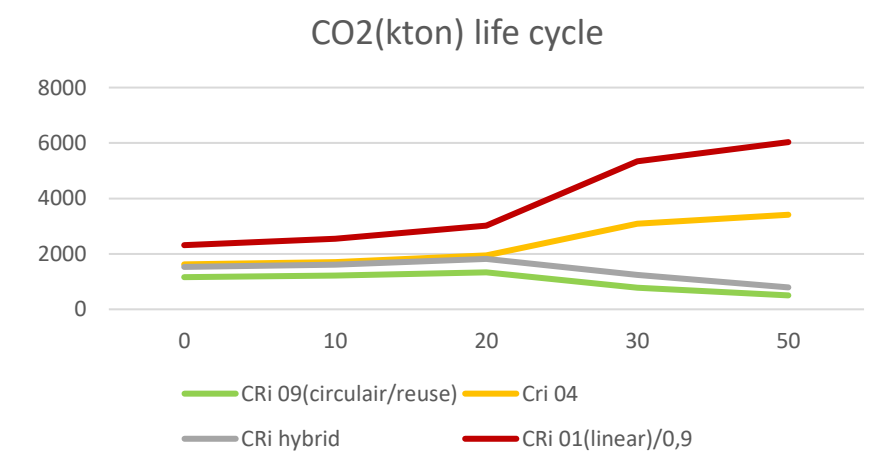
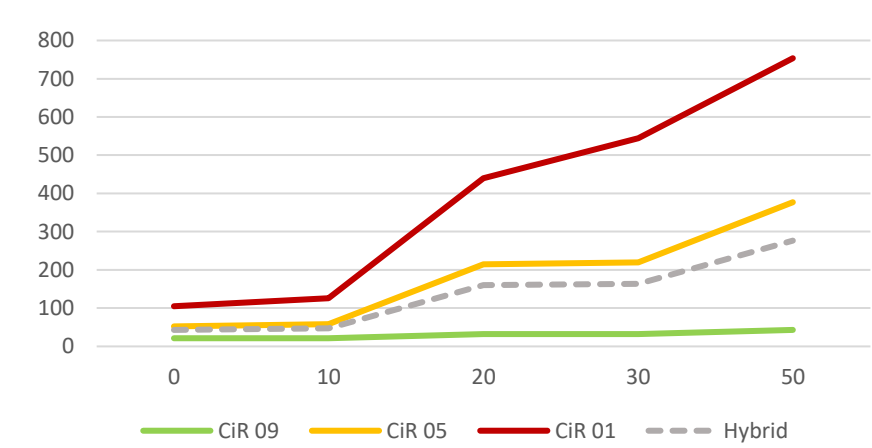
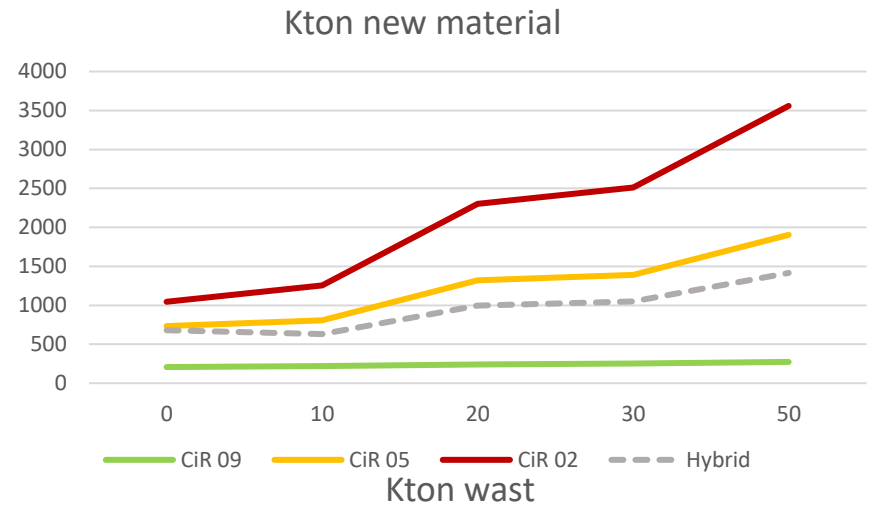
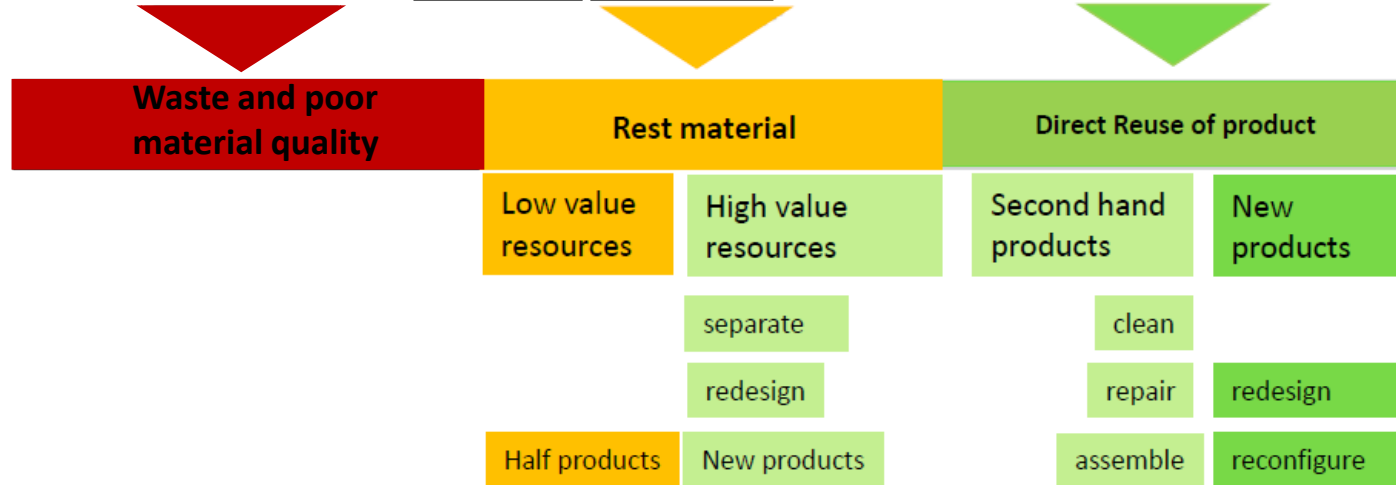


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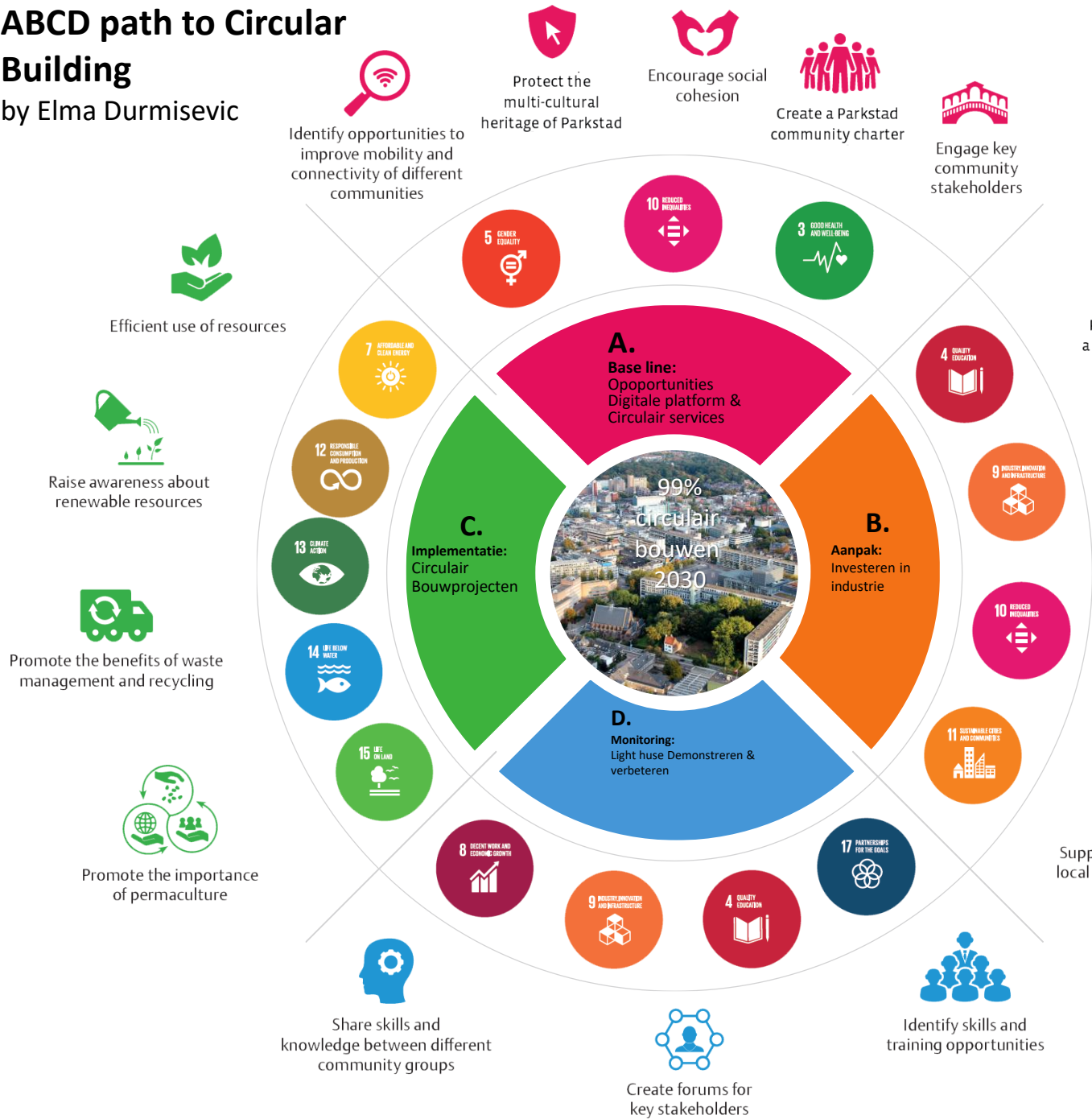
City material flows:

Product, good quality material and poor material flows



ABCD path to Circular Building

by Elma Durmisevic



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



Circular Building Region

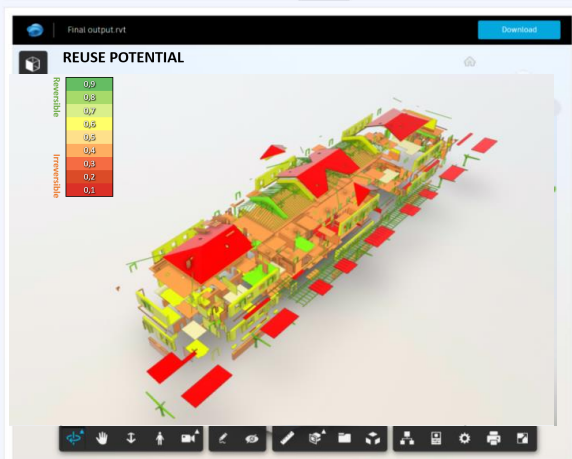
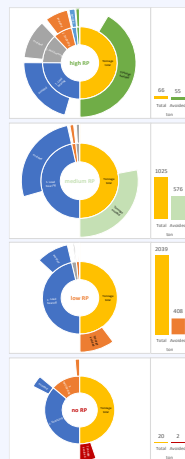
Integral view on circular, Carbon neutral and healthy building



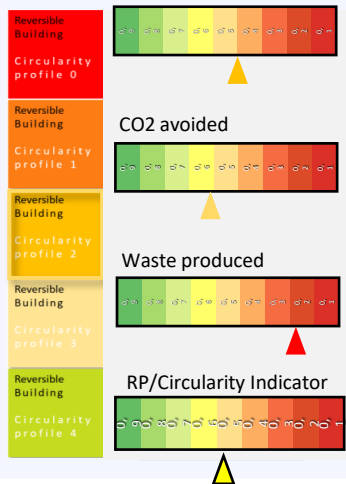
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Material substitution/ reuse



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Dr.Elma Durmisevic, Founder of SGDF



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