Research Fund for Coal & Steel

Large Valorisation on Sustainability of Steel Structures

MACRO-COMPONENTS AND *IPHONE* AND *IPAD* APPLICATIONS

U C FCTUC FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE DE COIMBRA

June 2014

Agenda

1) Macro-components approach

- Algorithm for life cycle assessment based in macro-components

2) iPad and iPhone Application

- Description of program

3) Final remarks

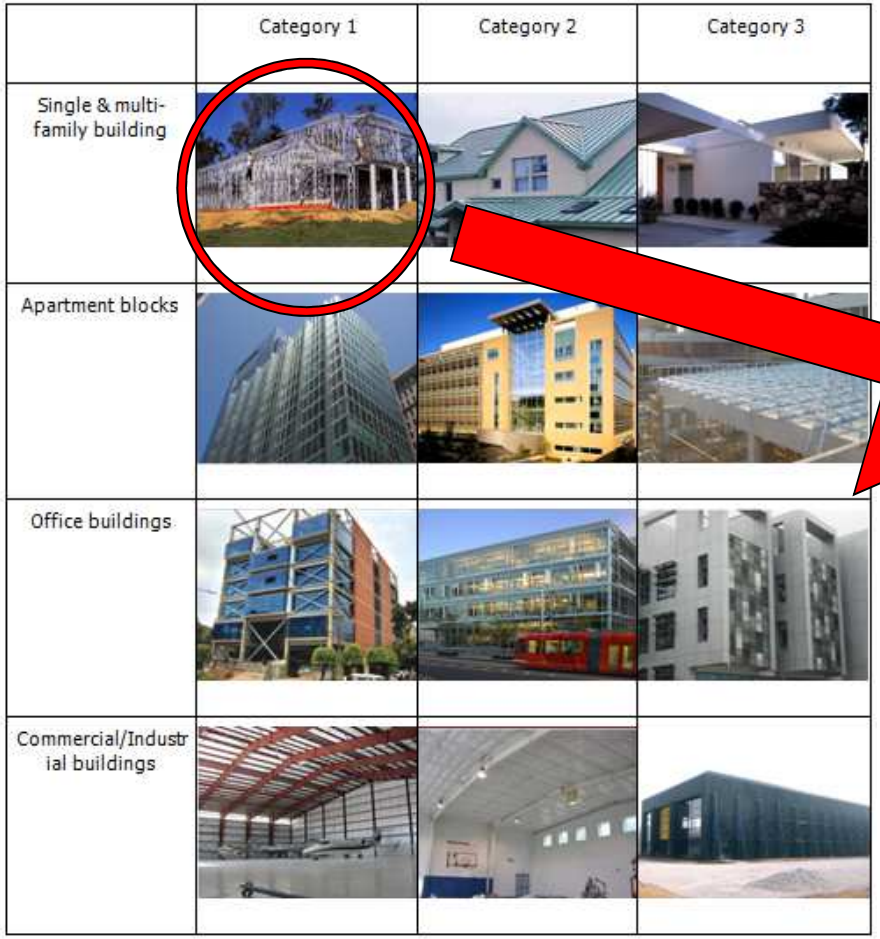
1) Macro-components approach

This methodology was previously developed under the RFCS research project

SB_Steel (2014), Sustainable Building Project in Steel. RFSR-CT-2010-00027

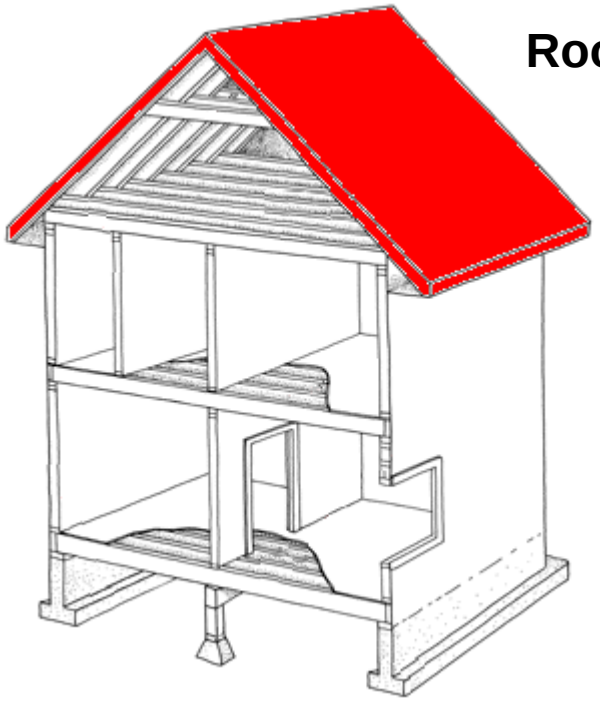
REFERENCE: Gervásio, H., Martins, R., Santos, P., Simões da Silva, L., "A macro-component approach for the assessment of building sustainability in early stages of design", Building and Environment 73 (2014), pp. 256-270, DOI information: 10.1016/j.buildenv.2013.12.015.

Steel-framed buildings classification



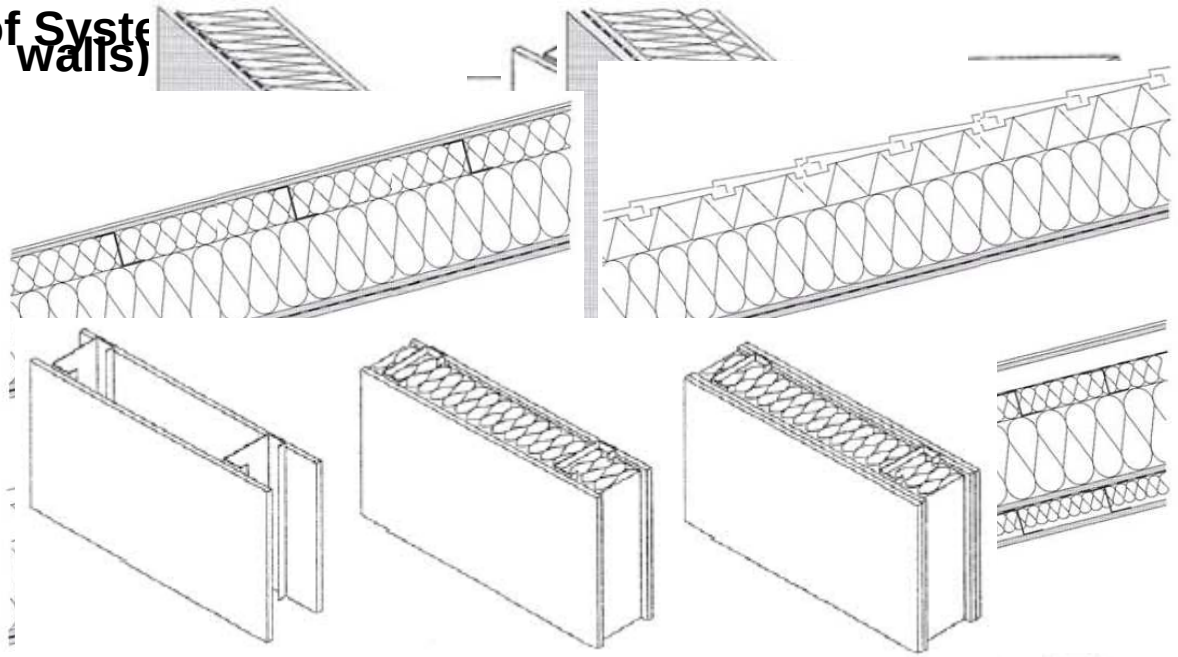
Single family house in Category 1 (steel intensive building)

MACRO-COMPONENT DEFINITION



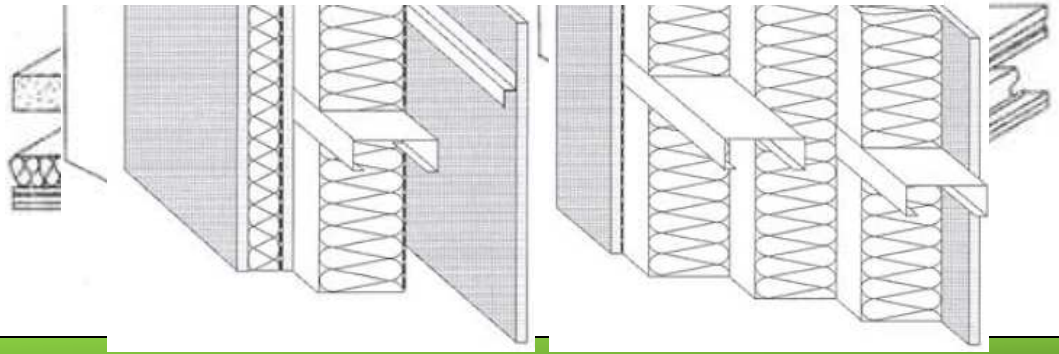
Roof System

Internal wall system (load-bearing walls)



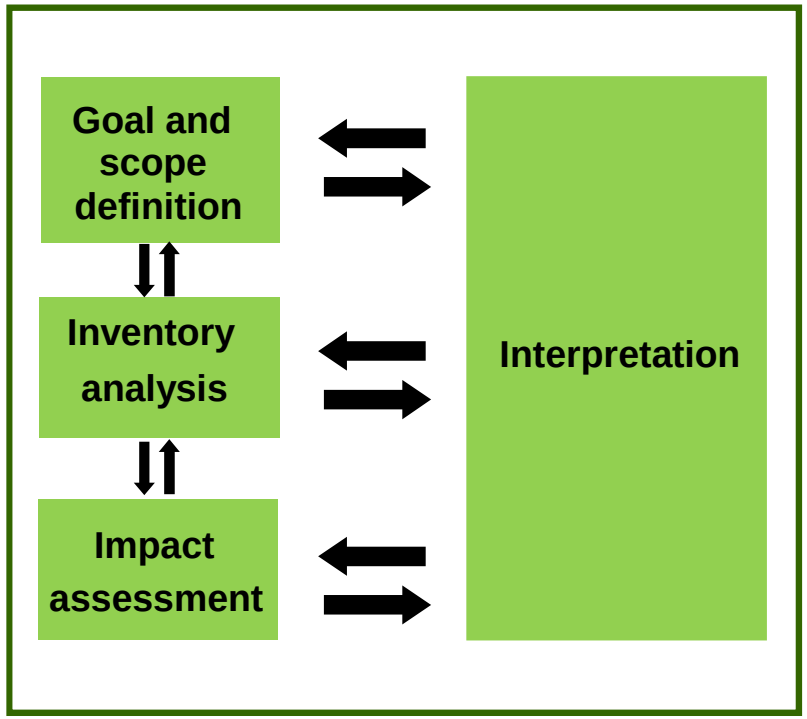
External wall system (load-bearing walls)

Floor system



MACRO-COMPONENT CALCULATION

ISO STANDARDS 14040/14044



Goal and scope

Two levels: LCA at (i) the component level; and (ii) the building level.

System boundaries

Product stage			Construc stage		Use stage							End-of-life stage				
Raw material supply	Transport	Manufacturing	Transport	Construction process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse/Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
x	x	x	x	-	-	x	x	x	x	-	-	x	x	x	x	x

Other relevant standards EN TC350 - Sustainability of construction works - EN 15643-2:2011

INVENTORY STAGE

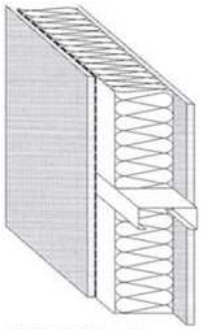
	Time coverage	Geographical coverage	Technology coverage	Completeness
Steel section	2007, annual average	Europe	European producers	> 99% of mass and energy
Steel rebar	2007, annual average	World	World producers	> 99% of mass and energy
Steel coil	2007, annual average	Europe	European producers	> 99% of mass and energy
Concrete C20/25	2011, annual average	Germany	German producers	> 95% of mass and energy
Oriented strand board OSB	2008, annual average	Germany	German producers	> 99% of mass and energy
Gympsum plasterboard	2008, annual average	Europe	European producers	> 95% of mass and energy
Bricks	2011, annual average	Germany	German producers	> 95% of mass and energy
Rock wool	2011, annual average	Europe	European producers	> 95% of mass and energy
Expanded polystyrene EPS	2011, no data	Europe	No data	No data
Extruded polystyrene XPS	2011, annual average	Germany	German producers	> 95% of mass and energy
Polyurethane rigid foam PUR	2011, annual average	Germany	German producers	> 95% of mass and energy
Expanded Cork	2011, annual average	Germany	German producers	> 95% of mass and energy
Glass wool	2011, annual average	Europe	European producers	> 95% of mass and energy
Polyethylene foam PE	2011, annual average	Germany	German producers	> 95% of mass and energy

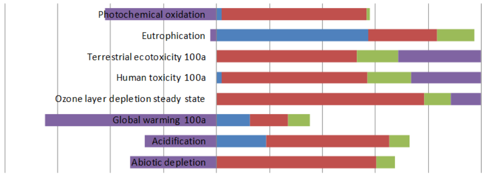
LARGE VALORISATION ON SUSTAINABILITY OF STEEL STRUCTURES

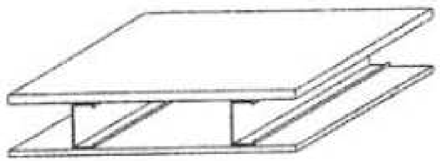
Research Fund for Coal & Steel

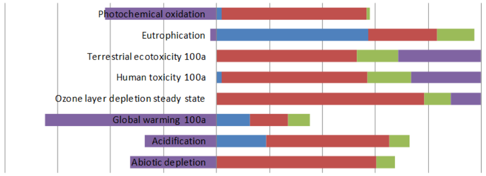
MACRO-COMPONENTS DATABASE

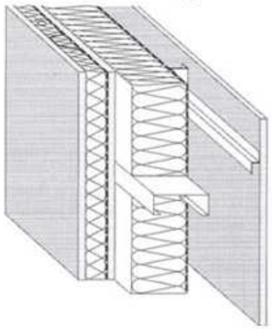
External wall type	Environmental profile	Floor system type	Environmental profile

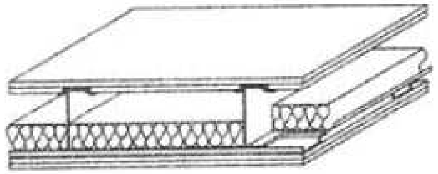


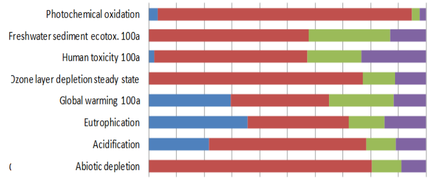


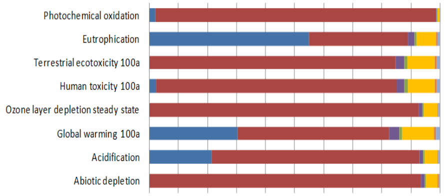


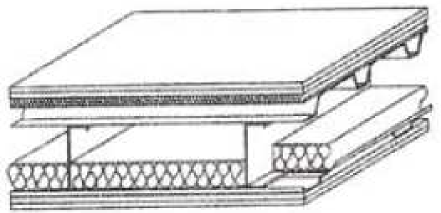


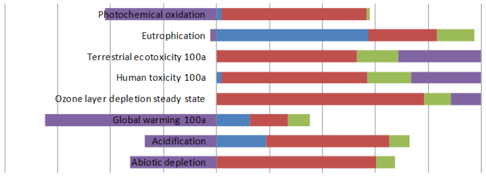


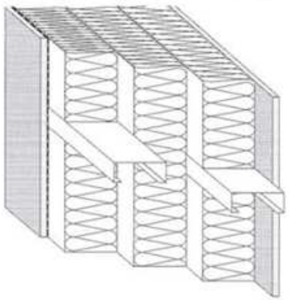


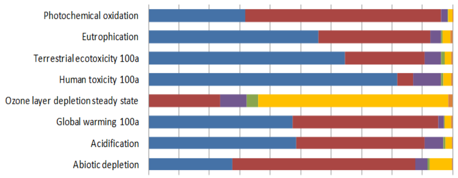


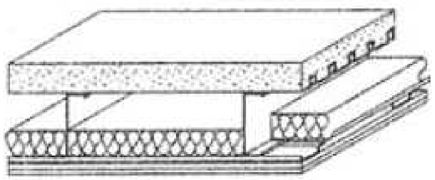


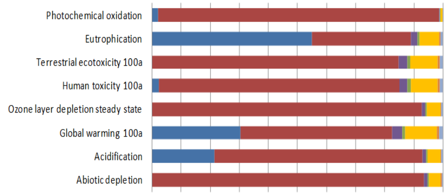












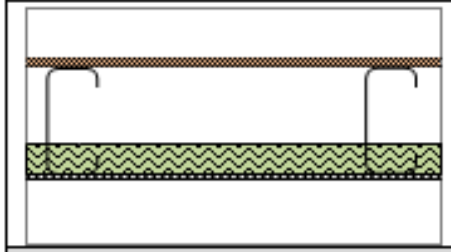
MACRO-COMPONENTS CLASSIFICATION

(A) Substructure	(A40) Slabs-on-grade	(A4010) Standard slabs-on-grade	
(B) Shell	(B10) Superstructure	(B1010) Floor construction	(B1010.10) Floor structural frame
			(B1010.20) Floor decks, slabs and toppings
		(B1020) Roof construction	(B1020.10) Roof structural frame
			(B1020.20) Roof decks, slabs and sheathing
	(B20) Exterior vertical enclosures	(B2010) Exterior walls	(B2010.10) Ext. wall veneer
			(B2010.20) Ext. wall construction
		(B2020) Exterior windows	
		(B2050) Exterior doors	
	(B30) Exterior horizontal enclosures	(B3010) Roofing	
		(B3060) Horizontal openings	
(C) Interiors	(C10) Interior construction	(C1010) Interior partitions	
	(C20) Interior finishes	(C2010) Wall finishes	
		(C2030) Flooring	
		(C2050) Ceiling finishes	

MACRO-COMPONENTS DATABASE

EXAMPLE:

B1010.10 Floor structural frame

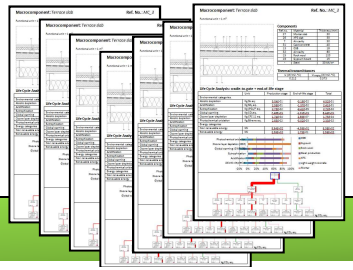
B1010.10.1a	Materials	Thickness/ density	End-of-life scenario	RR (%)
	OSB (mm)	18	Incineration	80
	Air cavity (mm)	160		
	Rock wool (mm)	40	Recycling	80
	Gypsum board (mm)	15	Recycling	80
	LWS (kg/m2)	14	Recycling	90

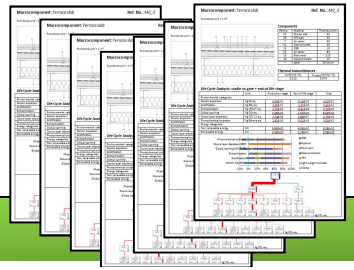
B1010.10.1a - LCA

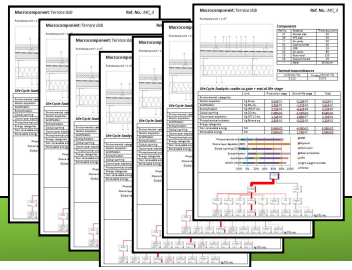
	A1-A3	A4	C2	C4	D
ADP elements [kg Sb-Equiv.]	2,83E-05	1,76E-09	1,54E-09	3,37E-08	-1,96E-04
ADP fossil [MJ]	5,48E+02	6,54E-01	5,72E-01	1,31E+00	-3,35E+02
AP [kg SO2-Equiv.]	1,70E-01	2,11E-04	1,83E-04	5,74E-04	-4,45E-02
EP [kg Phosphate-Equiv.]	1,41E-02	4,86E-05	4,20E-05	8,79E-05	-1,01E-03
GWP [kg CO2-Equiv.]	5,12E+01	4,71E-02	4,12E-02	3,86E-01	-1,46E+01
ODP [kg R11-Equiv.]	7,65E-07	8,25E-13	7,21E-13	7,21E-11	1,76E-07
POCP [kg Ethene-Equiv.]	2,53E-02	-6,89E-05	-5,95E-05	1,49E-04	-1,07E-02

MACRO-COMPONENT DATABASE

	Category 1	Category 2	Category 3
Single & multi-family building			
Apartment blocks			
Office buildings			
Commercial/Industrial buildings			

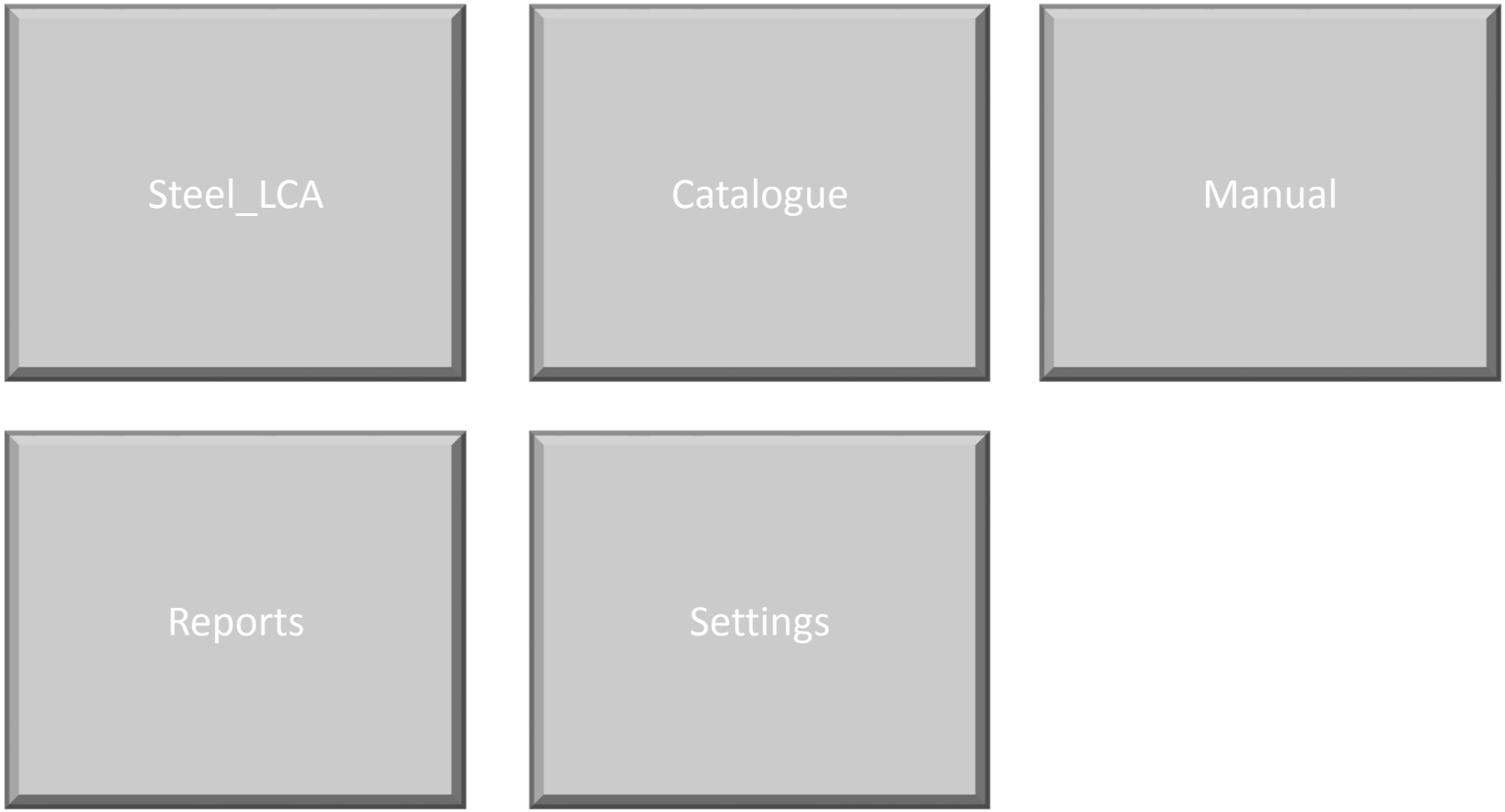






2) iPad and iPhone Application

Menu



Menu

Steel_LCA

Catalogue

Manual

Reports

Settings

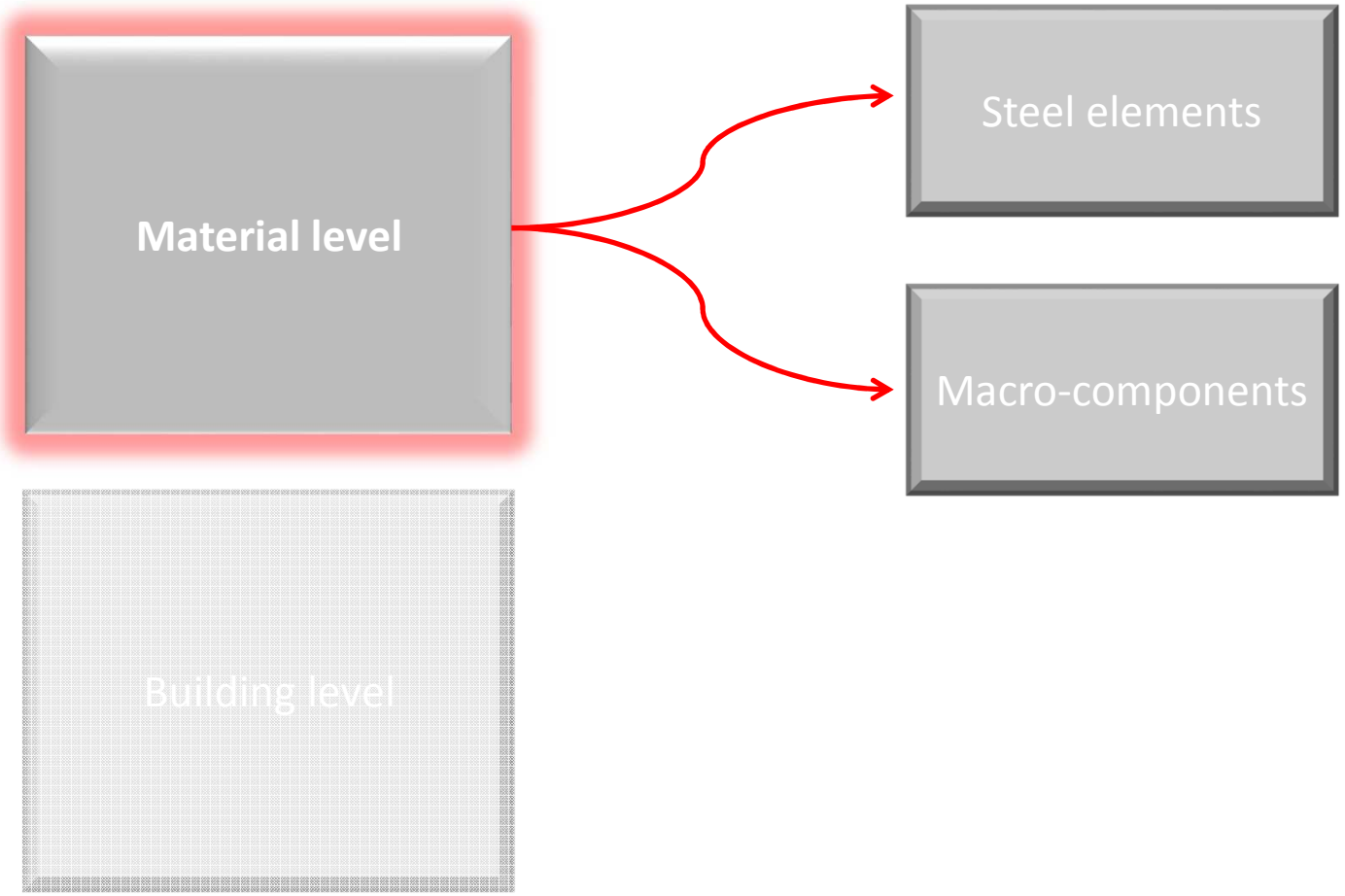
Menu >> Steel_LCA

Two levels of calculation:

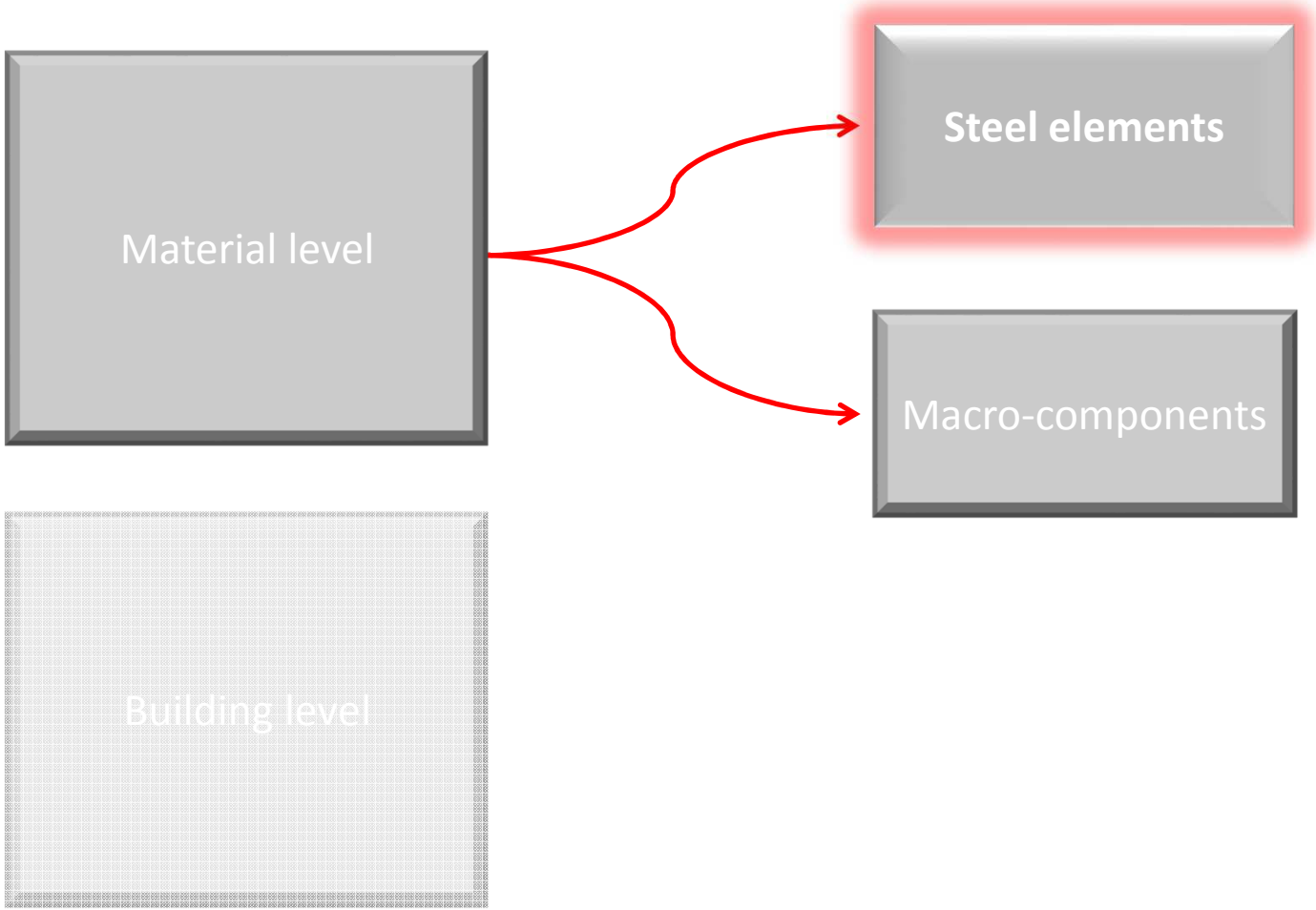
Material level → EN 15804:2012

Building level → EN 15978:2011

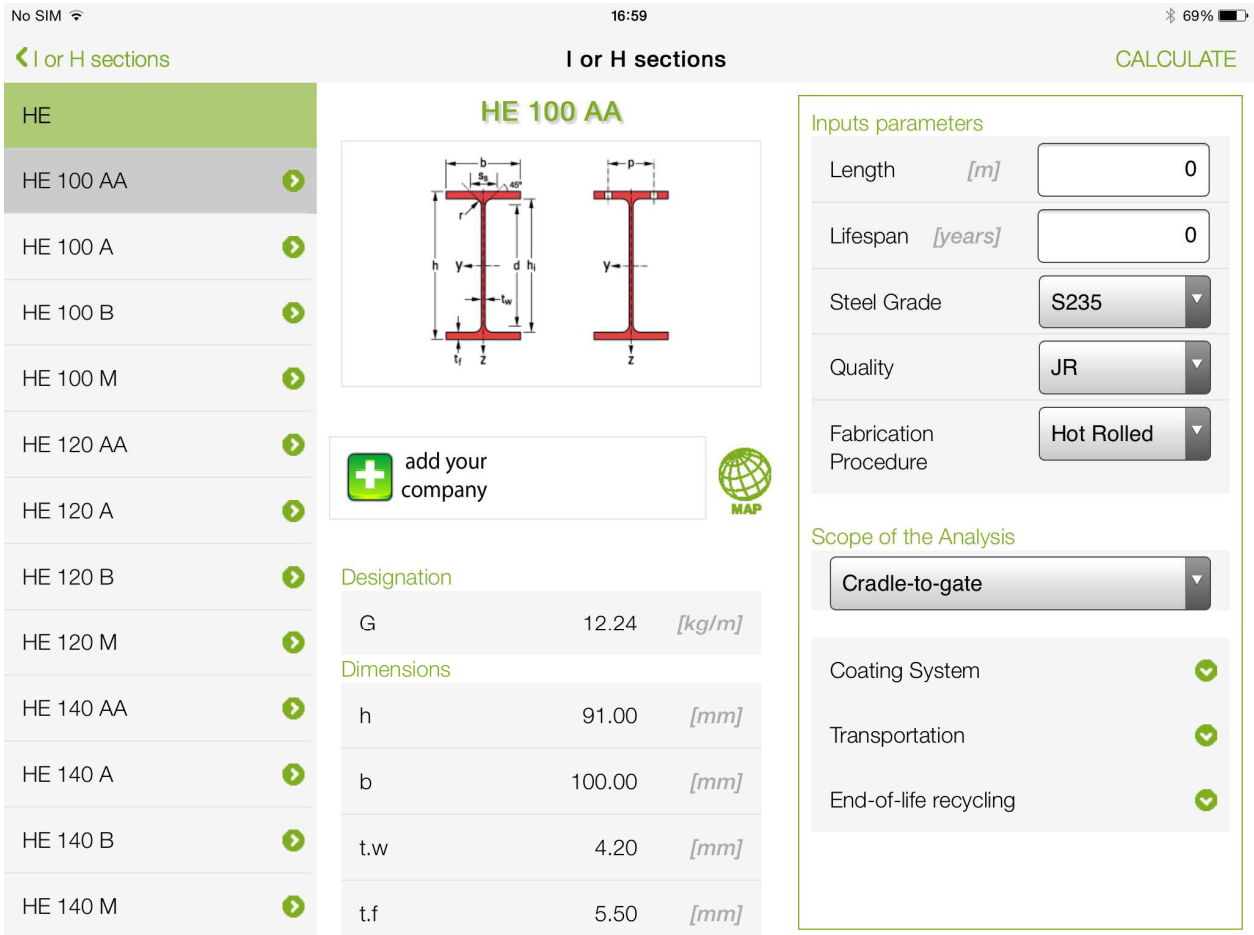
Menu >> Steel_LCA >> Material level



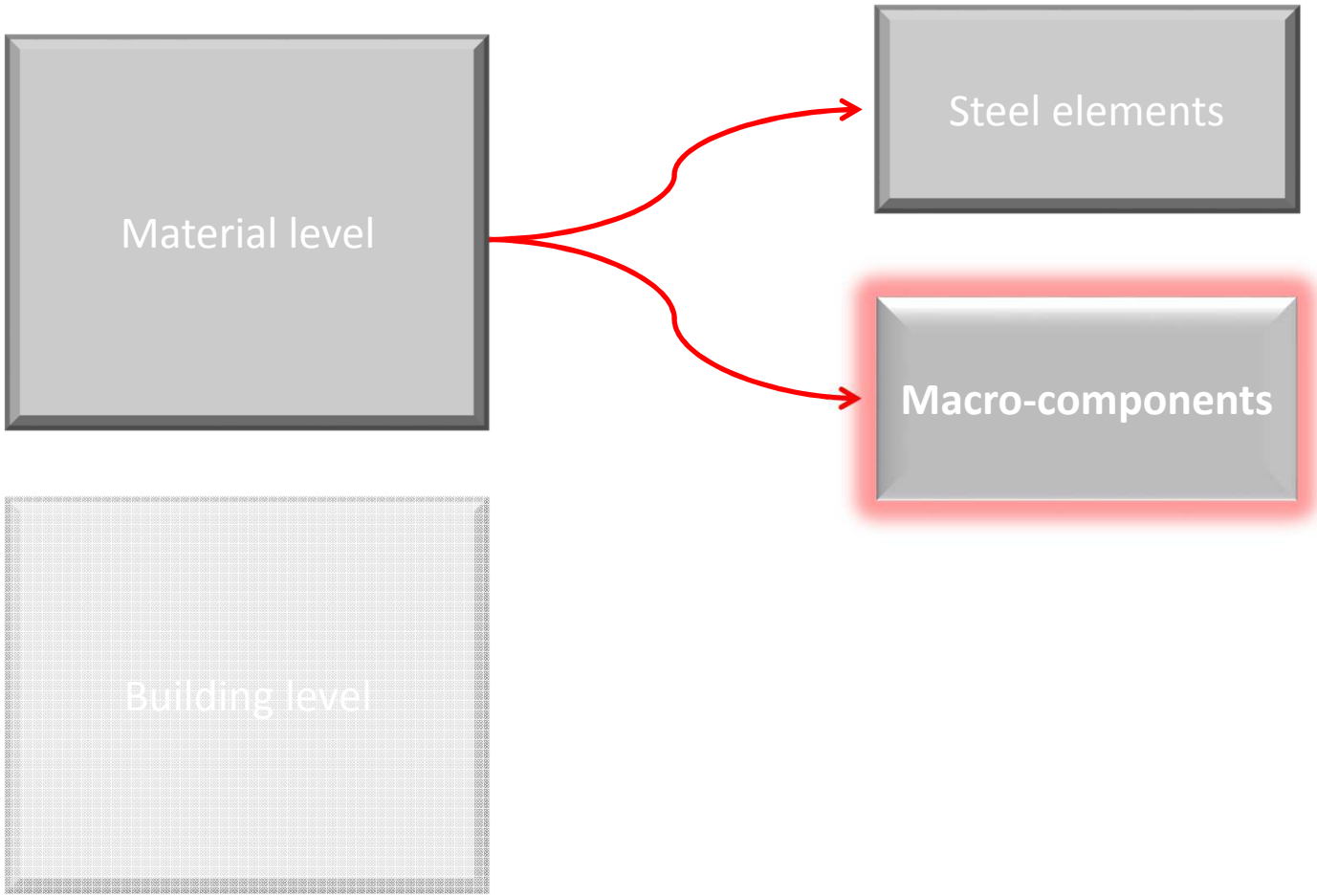
Menu >> Steel_LCA >> Material level



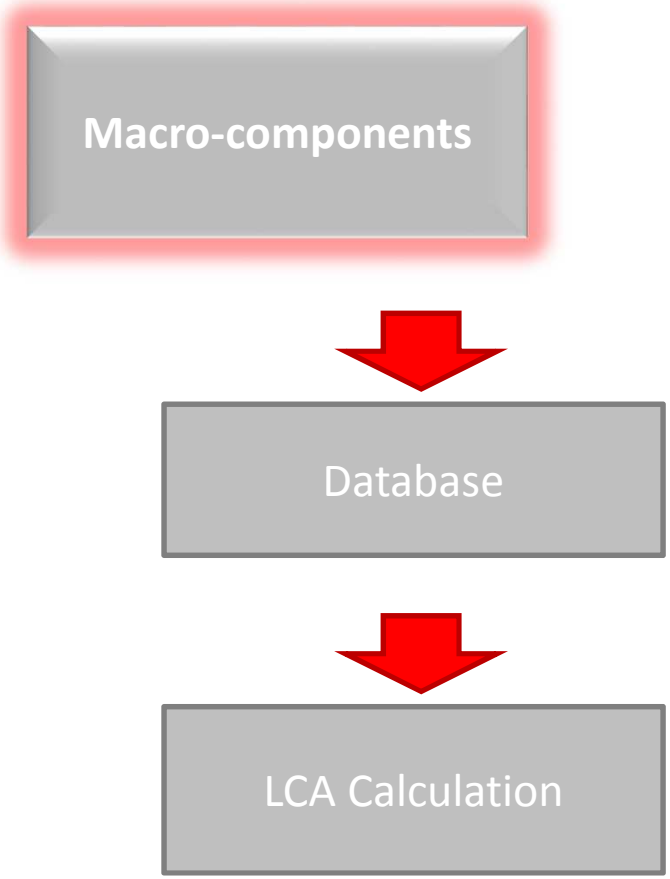
Menu >> Steel_LCA >> Material level



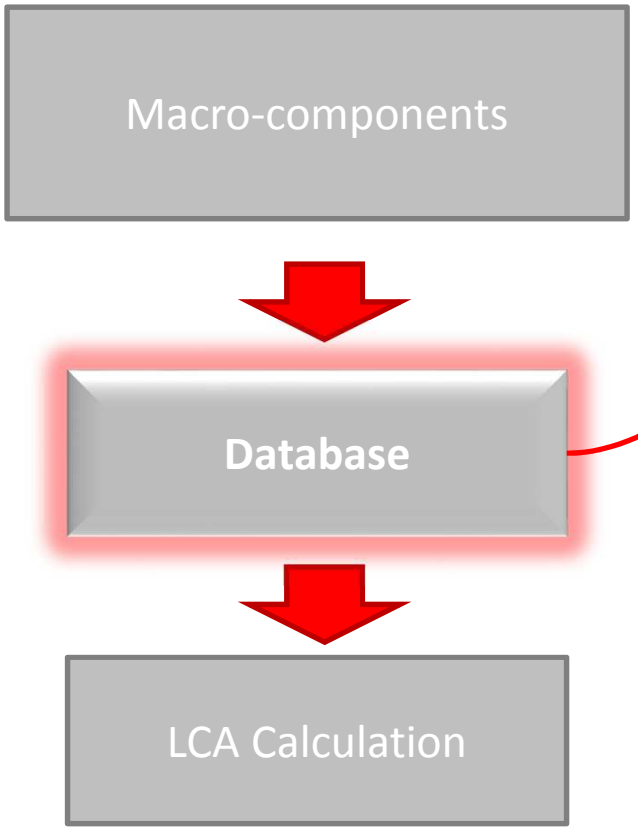
Menu >> Steel_LCA >> Material level



Menu >> Steel_LCA >> Material level >> Macro-components



Menu >> Steel_LCA >> Material level >> Macro-components



Selection of macro-components

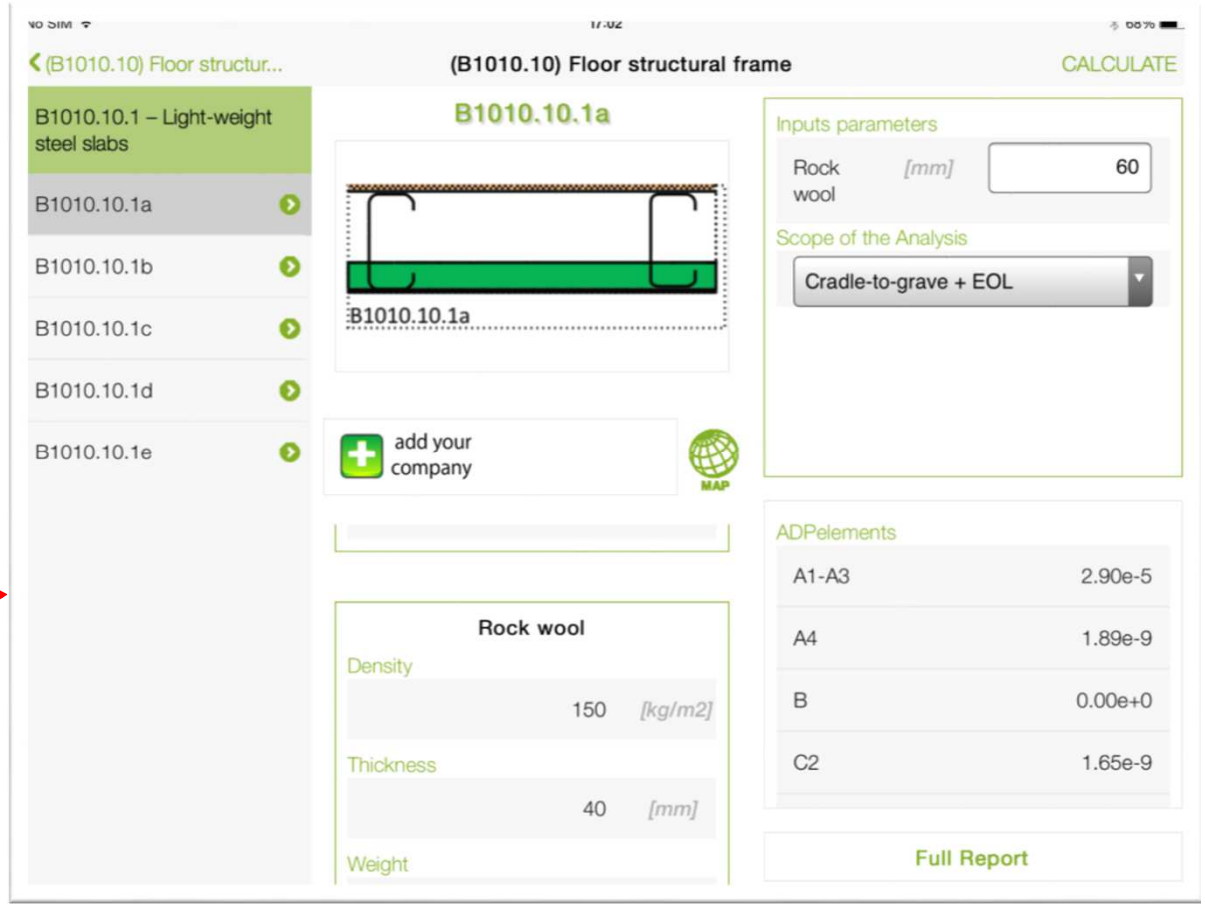
(A) Substructure	(A40) Slabs-on-grade	(A4010) Standard slabs-on-grade	
(B) Shell	(B10) Superstructure	(B1010) Floor construction	(B1010.10) Floor structural frame
			(B1010.20) Floor decks, slabs and toppings
		(B1020) Roof construction	(B1020.10) Roof structural frame
			(B1020.20) Roof decks, slabs and sheathing
	(B20) Exterior vertical enclosures	(B2010) Exterior walls	(B2010.10) Ext. wall veneer
			(B2010.20) Ext. wall construction
		(B2020) Exterior windows	
		(B2050) Exterior doors	
	(B30) Exterior horizontal enclosures	(B3010) Roofing	
		(B3060) Horizontal openings	
(C) Interiors	(C10) Interior construction	(C1010) Interior partitions	
	(C20) Interior finishes	(C2010) Wall finishes	
		(C2030) Flooring	
		(C2050) Ceiling finishes	

Menu >> Steel_LCA >> Material level >> Macro-components

Macro-components

Database

LCA Calculation



Menu >> Steel_LCA >> Building level

Material level

Building level

Menu >> Steel_LCA >> Building level >> Building selection

Building level

Building selection

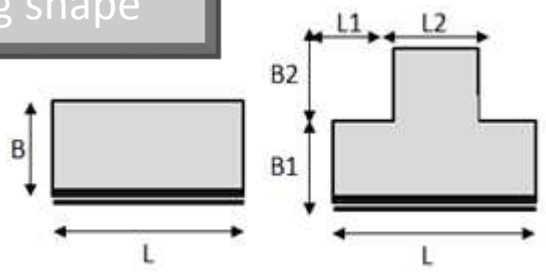
Macro-components

LCA calculation

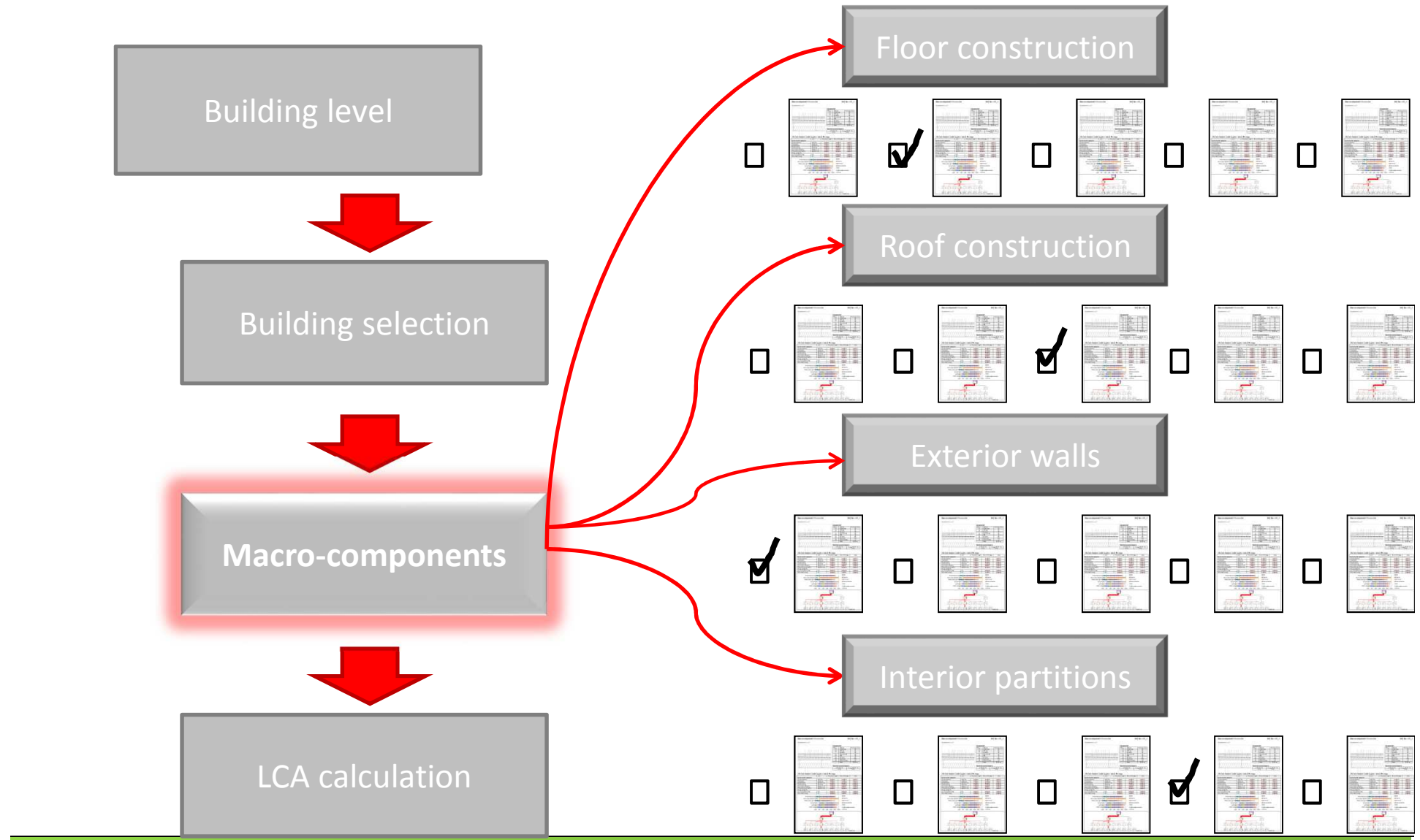
Building type

	Category 1	Category 2	Category 3
Single & multi-family building			
Apartment blocks			
Office buildings			
Commercial/Industrial buildings			

Building shape



LARGE VALORISATION ON SUSTAINABILITY OF STEEL STRUCTURES



Menu >> Steel_LCA >> Building level >> LCA calculation

Building level

Building selection

Macro-components

LCA calculation & report

LCA REPORT FOR STEEL BUILDINGS

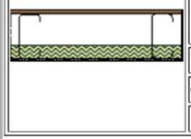
SUMMARY

Scope: Cradle-to-grave + EOL
Lifespan: 50 years
Environmental Impacts
LCA index: -1.42E-11
Global Warming Potential (GWP): 41 kg CO2 eq
Primary Energy Demand
Total Primary Energy Demand: 679 MJ

DETAILED RESULTS

LCA Input Data

B1010.10 Floor structural frame



Materials	Thickness (mm)	End-of-life scenario	RR (%)
Light weight steel (LWS)		Recycling	90
OSB	18	Incineration	80
Gypsum pasterboard	15	Recycling	80
Rock wool	40	Recycling	80

LCA Results

LCA of 1m2 of a Roof macro-component

Parameters describing enviromental impacts

Indicator	Unit	A1-A3	A4	B1-B5	C2	C4	D	TOTAL
ADP elements	[kg Sb Eq.]	2.90e-5	1.89e-9	0.00e+0	1.65e-9	3.67e-8	-1.97e-4	-1.68e-4
ADP fossil	[MJ]	5.88e+2	7.02e-1	0.00e+0	6.14e-1	1.43e+0	-3.36e+2	2.55e+2
AP	[kg SO2 Eq.]	1.93e-1	2.27e-4	0.00e+0	1.97e-4	6.25e-4	-4.45e-2	1.50e-1
EP	[kg PO4- Eq.]	1.66e-2	5.22e-5	0.00e+0	4.51e-5	9.59e-5	-1.01e-3	1.58e-2
GWP	[kg CO2 Eq.]	5.46e+1	5.06e-2	0.00e+0	4.41e-2	4.20e-1	-1.46e+1	4.05e+1
ODP	[kg CFC-11 Eq.]	7.65e-7	8.86e-13	0.00e+0	7.73e-13	7.85e-11	1.76e-7	9.42e-7
POCP	[kg C2H4 Eq.]	2.70e-2	-7.40e-5	0.00e+0	-6.38e-5	1.62e-4	-1.07e-2	1.63e-2

3) Final remarks

- The simplified approach for LCA avoids the use of complex tools and the use of expert professionals in the field and provides substantial reduction in the time usually needed to perform such analysis.

- The validation of the approach was based on the comparison with advanced analyses performed by the use of commercial software GaBi 6.

- The comparison of the results enables to conclude that the accuracy of both approaches is very reasonable.