

Research Fund
for Coal & Steel



Valorisation de la durabilité des structures en acier

MACRO-ÉLÉMENTS ET APPLICATION *IPHONE* ET *IPAD*



Plan

1) Approche par macro-éléments

- Algorithme pour l'analyse de cycle de vie fondé sur les macro-éléments

2) Application Iphone et Ipad

- Description du programme

3) Conclusions

1) Approche par macro-éléments

Cette méthodologie a été développée dans le cadre du projet RFCS















SB STEEL

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.

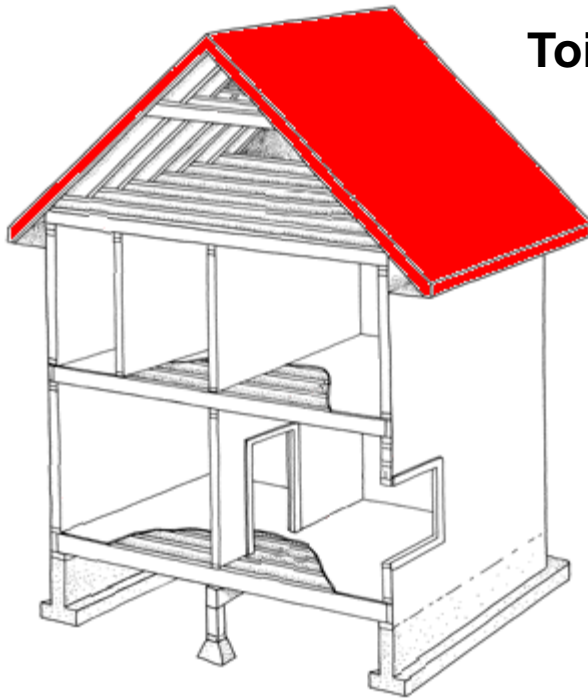
Classification des bâtiments en acier de type portique

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

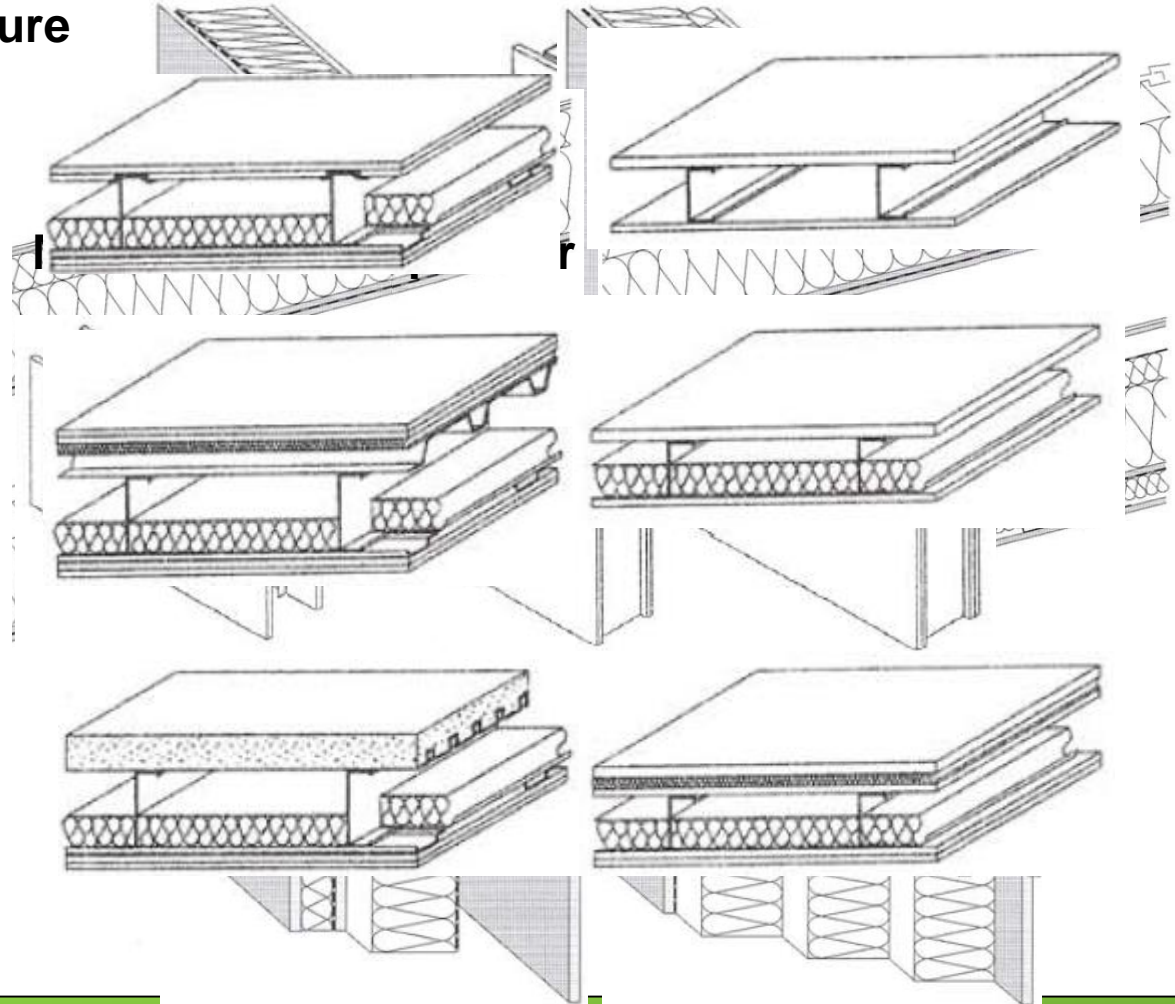
**Maison unifamiliale
dans la Catégorie 1
(solution avec
utilisation intensive
de l'acier)**

DEFINITION DES MACRO-ÉLÉMENTS

Mur interne porteur
Toiture



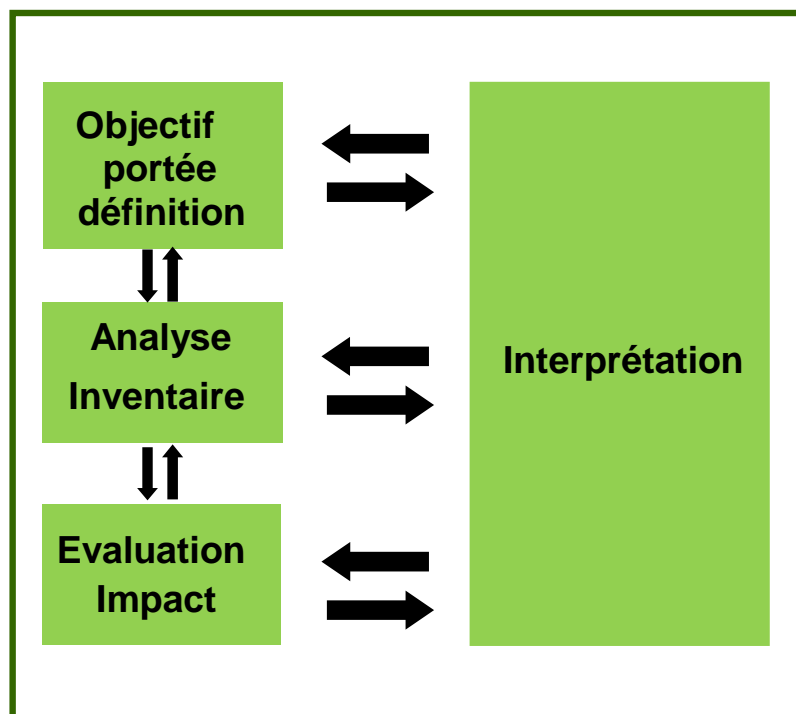
Mur externe porteur
Plancher





CALCUL DES MACRO-ÉLÉMENTS

ISO STANDARDS 14040/14044



Objectives

Deux niveaux: LCA (i) au niveau des éléments; et
(ii) au niveau des bâtiments.

Limites du système

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
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
x	x	x	x	-	-	x	x	x	x	-	-	x	x	x	x

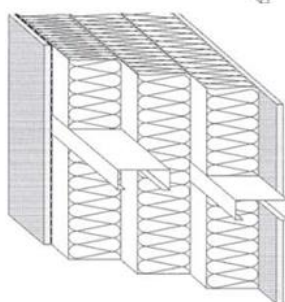
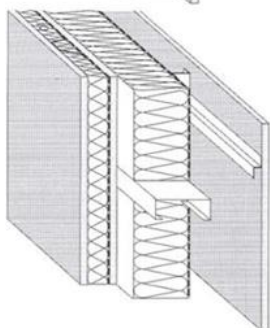
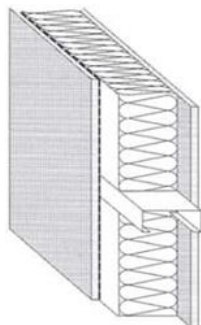
Autres normes intéressantes EN TC350 - Sustainability of
construction works - EN 15643-2:2011

INVENTAIRE

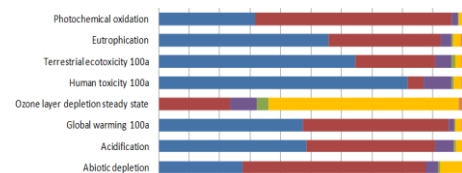
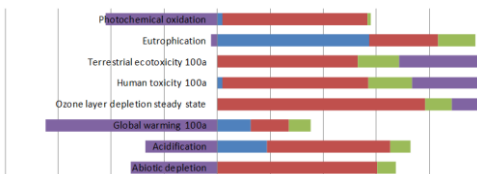
	Time coverage		Geographical coverage	Technology coverage	Completeness
Steel section	2007,	annual average	Europe	European producers	> 99% of mass and energy
Steel rebar	2007,	annual average	World	World producers	> 99% of mass and energy
Steel coil	2007,	annual average	Europe	European producers	> 99% of 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
Gypsum 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

BASE DE DONNÉES DE MACRO-ÉLÉMENTS

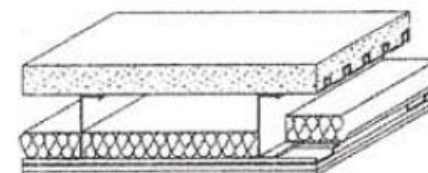
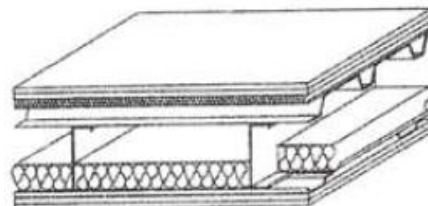
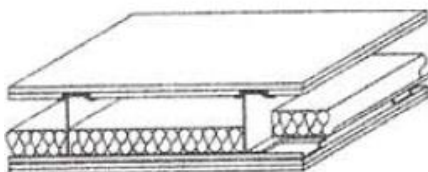
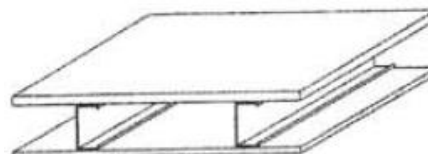
Type de mur externe



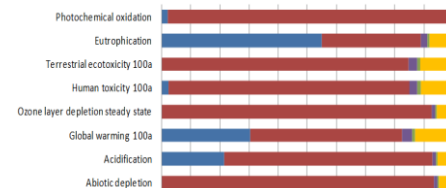
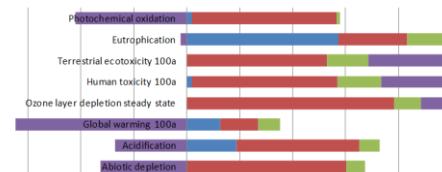
Profile environnemental



Type de plancher



Profile environnemental





CLASSIFICATION DES MACRO-ÉLÉMENTS

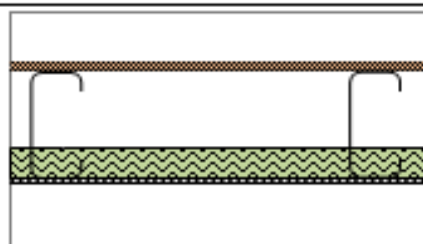
(A) Substructure	(A40) Slabs-on-grade	(A4010) Standard slabs-on-grade	
(B) Shell	(B10) Superstructure	(B1010) Floor construction	(B1010.10) Floor structural frame
			(B1010.20) Floor decks, slabs and toppings
		(B1020) Roof construction	(B1020.10) Roof structural frame
			(B1020.20) Roof decks, slabs 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	

BASE DE DONNÉES DE MACRO-ÉLÉMENTS

EXEMPLE:

B1010.10 Floor structural frame

B1010.10.1a



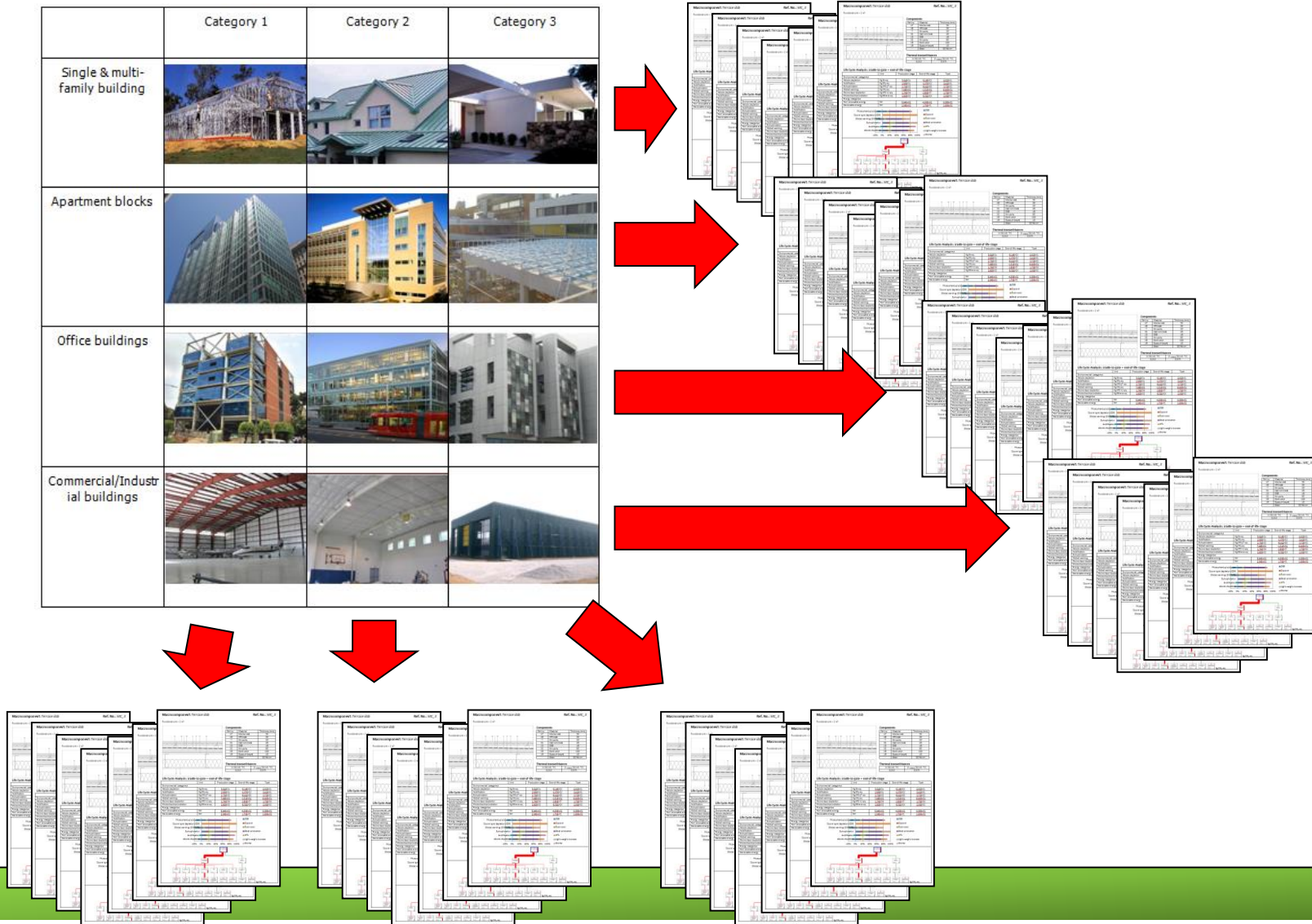
Materials	Thickness/ density	End-of-life scenario	RR (%)
OSB (mm)	18	Incineration	80
Air cavity (mm)	160		
Rock wool (mm)	40	Recycling	80
Gypsum board (mm)	15	Recycling	80
LWS (kg/m2)	14	Recycling	90

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

Valorisation de la durabilité des structures en acier

BASE DE DONNÉES DE MACRO-ÉLÉMENTS





2) Application Ipad et Iphone

Menu

Acier_LCA

Catalogue

Manuel

Rapports

Paramètres



Menu

Acier_LCA

Catalogue

Manuel

Rapports

Paramètres



Menu >> Acier_LCA

Deux niveaux de calcul:

Niveau matériau



EN 15804:2012

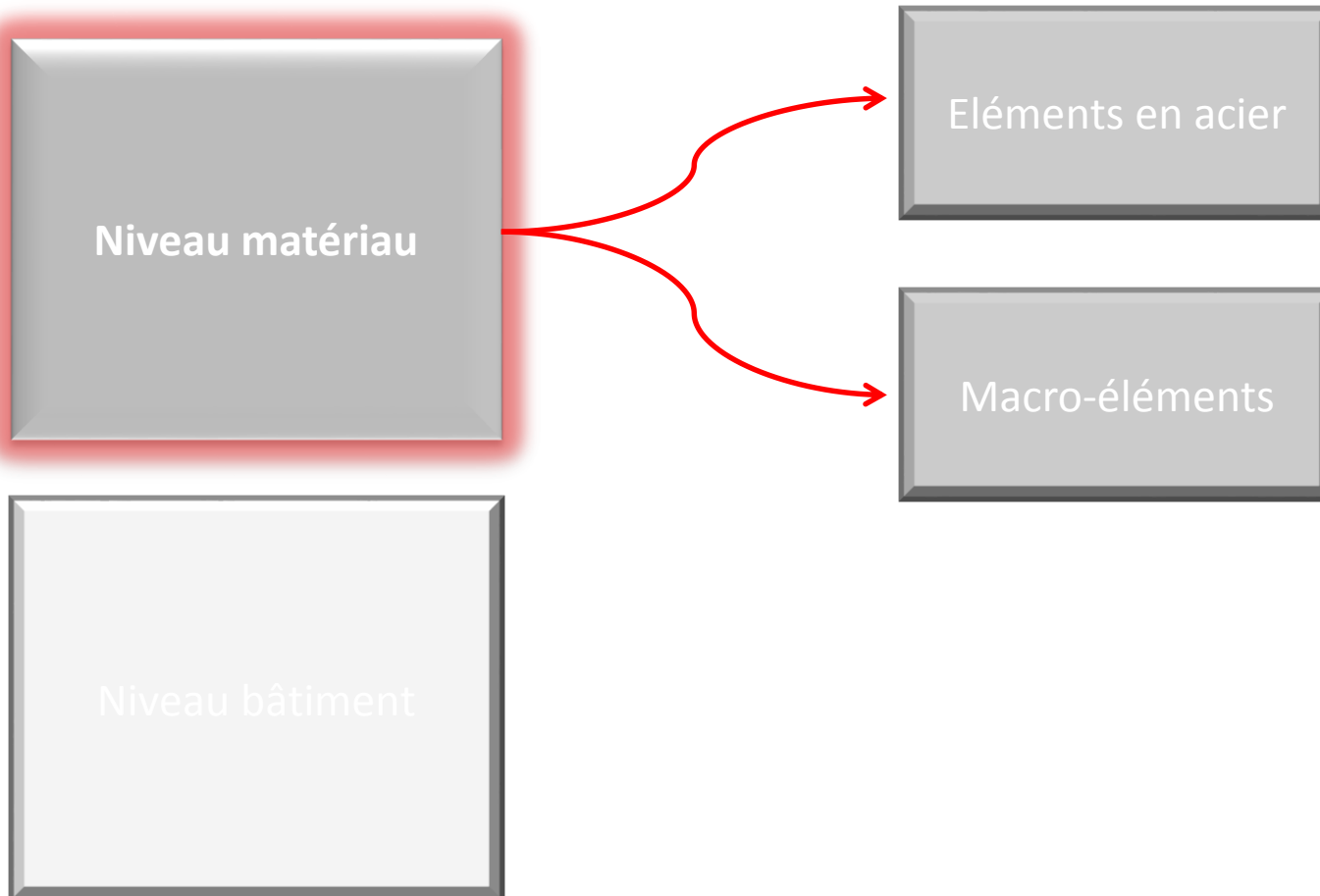
Niveau bâtiment



EN 15978:2011

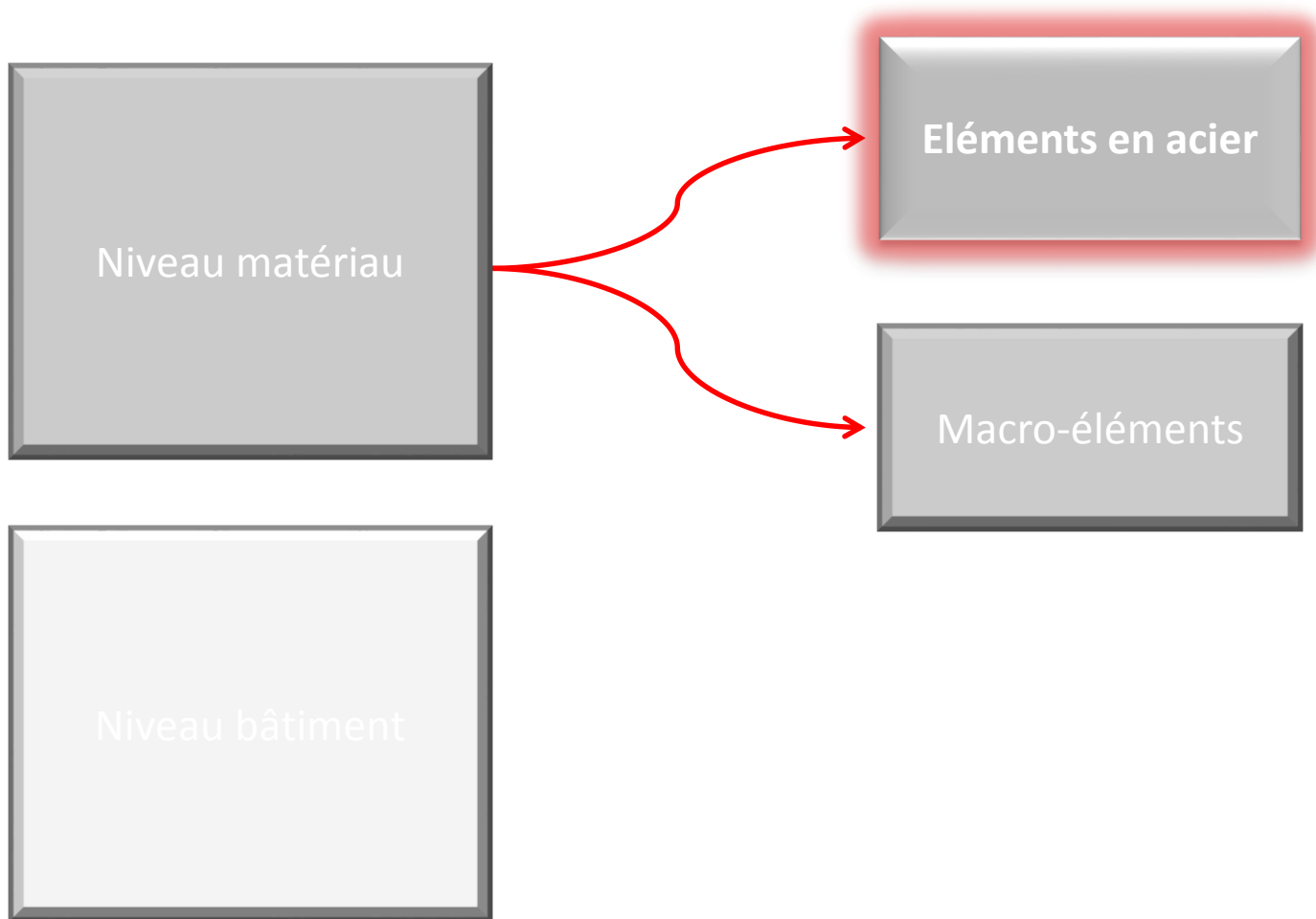


Menu >> Acier_LCA >> Niveau matériau





Menu >> Acier_LCA >> Niveau matériau





Menu >> Acier_LCA >> Niveau matériau

No SIM
16:59
69%

I or H sections
CALCULATE

I or H sections

HE

HE 100 AA
HE 100 A
HE 100 B
HE 100 M
HE 120 AA
HE 120 A
HE 120 B
HE 120 M
HE 140 AA
HE 140 A
HE 140 B
HE 140 M

HE 100 AA

+ add your company

Designation

G	12.24	[kg/m]
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Dimensions

h	91.00	[mm]
b	100.00	[mm]
t.w	4.20	[mm]
t.f	5.50	[mm]

Inputs parameters

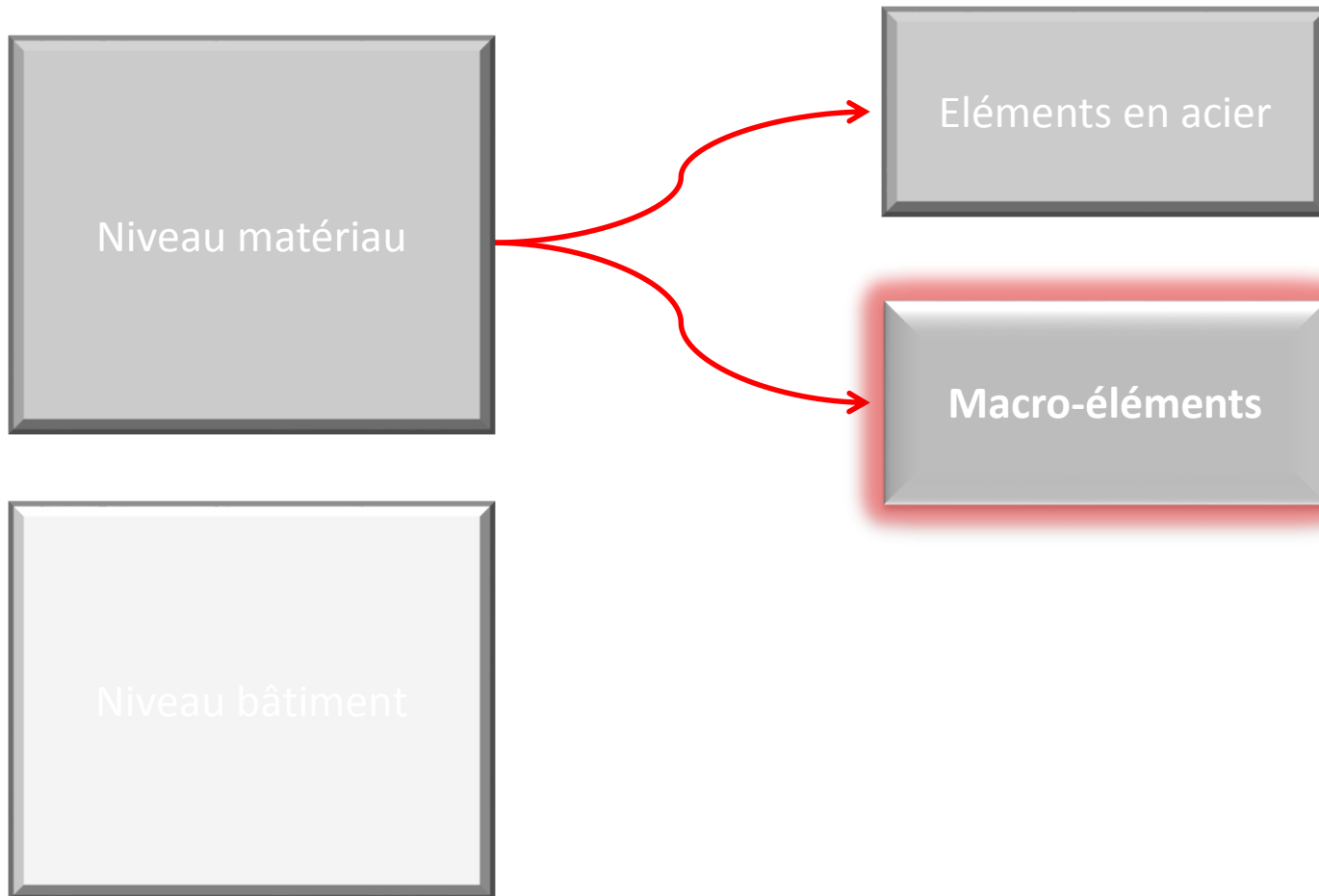
Length [m] 0
Lifespan [years] 0
Steel Grade S235
Quality JR
Fabrication Procedure Hot Rolled

Scope of the Analysis

Cradle-to-gate

Coating System
Transportation
End-of-life recycling

Menu >> Acier_LCA >> Niveau matériau





Menu >> Acier_LCA >> Niveau matériau
>> Macro-éléments

Macro-éléments



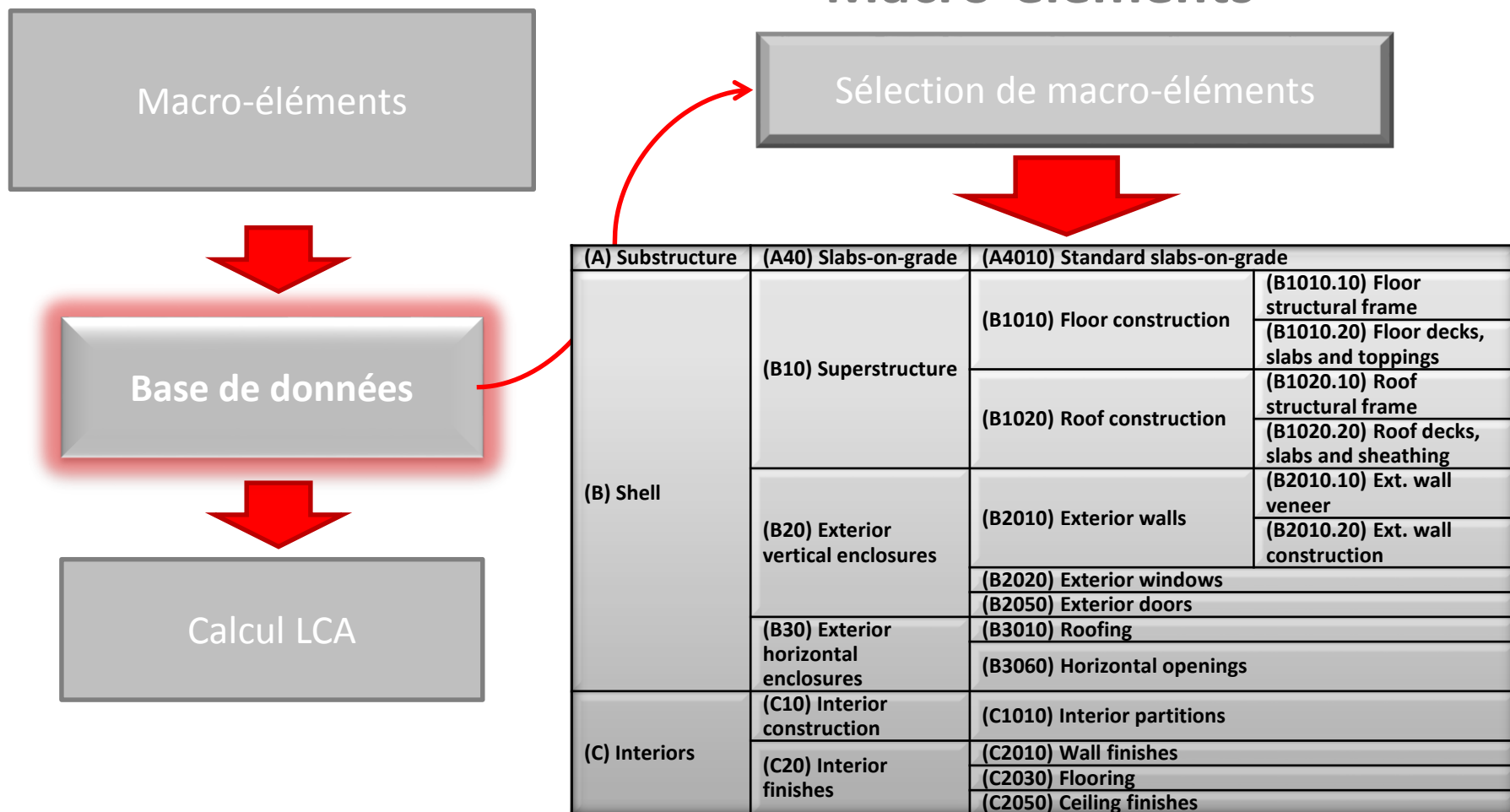
Base de données



Calcul LCA



Menu >> Acier_LCA >> Niveau matériau >> Macro-éléments





Menu >> Acier_LCA >> Niveau matériau >> Macro-éléments

Macro-éléments



Base de données



Calcul LCA

(B1010.10) Floor structur...

(B1010.10) Floor structural frame

B1010.10.1 – Light-weight steel slabs

B1010.10.1a

B1010.10.1b

B1010.10.1c

B1010.10.1d

B1010.10.1e

+ add your company

MAP

Rock wool

Density 150 [kg/m²]

Thickness 40 [mm]

Weight

Inputs parameters

Rock wool [mm] 60

Scope of the Analysis

Cradle-to-grave + EOL

ADPelements

A1-A3	2.90e-5
A4	1.89e-9
B	0.00e+0
C2	1.65e-9

Full Report

CALCULATE

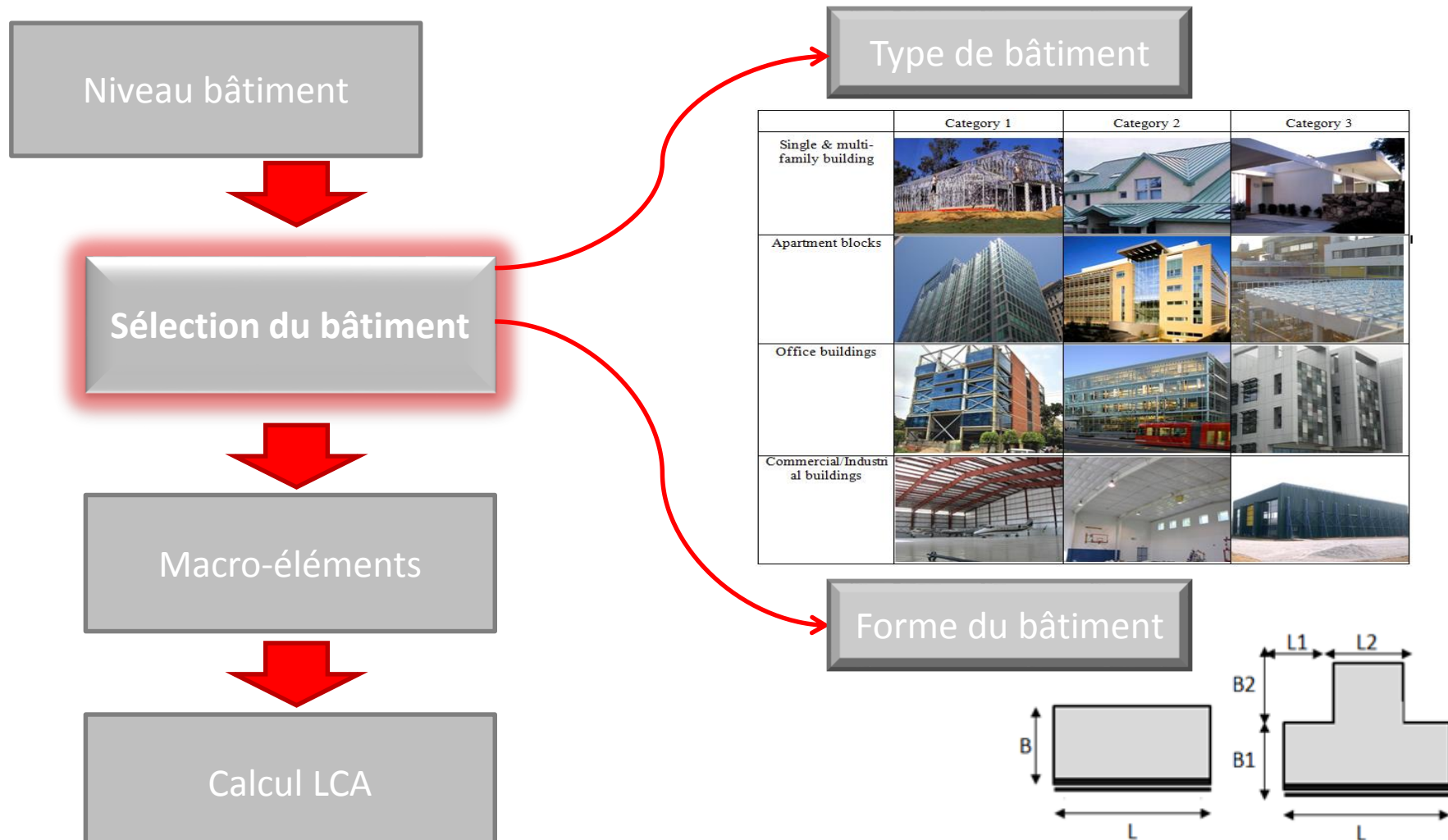


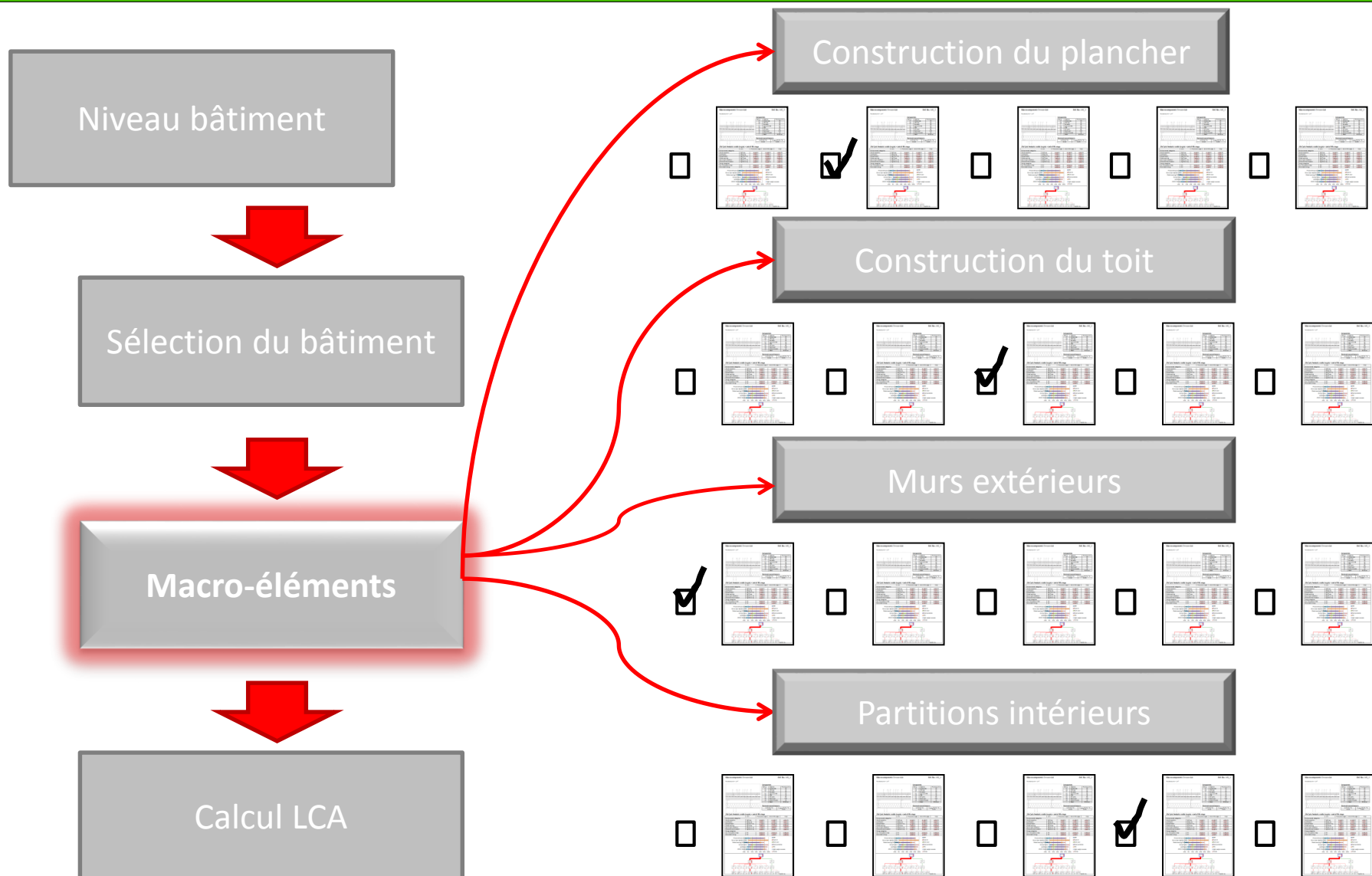
Menu >> Acier_LCA >> Niveau bâtiment

Niveau matériau

Niveau bâtiment

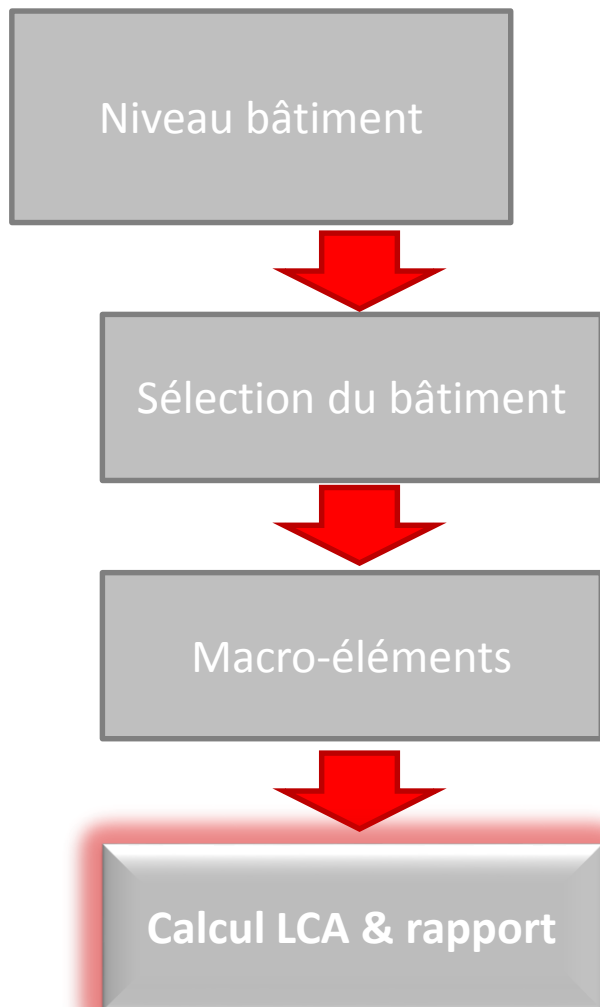
Menu >> Acier_LCA >> Niveau bât. >> Sélection du bât.







Menu >> Acier_LCA >> Niveau bâtiment >> Calcul LCA



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 plasterboard	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 SO ₂ Eq.]	1.93e-1	2.27e-4	0.00e+0	1.97e-4	6.25e-4	-4.45e-2	1.50e-1
EP	[kg PO ₄ - Eq.]	1.66e-2	5.22e-5	0.00e+0	4.51e-5	9.59e-5	-1.01e-3	1.58e-2
GWP	[kg CO ₂ Eq.]	5.48e+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	8.88e-13	0.00e+0	7.73e-13	7.95e-11	1.78e-7	9.42e-7
POCP	[kg C ₂ H ₄ Eq.]	2.70e-2	-7.40e-5	0.00e+0	-6.38e-5	1.62e-4	-1.07e-2	1.63e-2



3) Conclusions

- L'approche simplifiée pour l'analyse de cycle de vie permet d'éviter l'utilisation d'outils sophistiqués et de faire appel à des experts du domaine. Elle permet également une réduction significative du temps habituellement nécessaire pour la réalisation de ce type d'analyse.
- La validation de cette approche a été réalisée via des comparaisons à des résultats obtenus via un outil d'analyse avancée disponible sur le commerce, le logiciel GaBi 6.
- La comparaison des résultats a permis de conclure que l'approche simplifiée proposée permet d'obtenir une précision raisonnable.