POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE
Degree in Architecture
Honors theses

Environmental quality of building materials. Application of LCA (Life Cycle Assessment) methodology for the civil roof

by Andrea Quarello
Tutor: Marco Filippi
Co-tutors: Guglielmina Mutani, Fulvio Taiariol

In the near future several sectors of industry, building and transport should contribute to the reduction of air and water pollution causing environmental damage such as the greenhouse effect or the ozone layer depletion.

In particular, the construction industry should reduce the energy and resources used for building making, i.e. lower energy and material consumption.

The first step is to choose, at an early project stage, materials and planning solutions calling for a low waste of energy and resources.

Designers should eventually be provided with the tools to evaluate the environmental and energy performances of a building.

In this dissertation a survey method called LCA has been used to evaluate the environmental and energetic impact of a building component, the roof.

Internationally recognised by means of ISO 14040 and subsequent Standards Organisations, the LCA (Life Cycle Assessment), is currently the most reliable tool in the evaluation of energy and environmental impacts in a production process.

Given the survey tool, its application limits and goals, we must track down data regarding these production processes of the building materials that make up the implementation of the "roofing" functional unit.

All data on the subject have been collected in a database, every card of which contains values taken from Italian and European production standards regarding the whole manufacturing process of materials: air and water release, energy consumption and waste production.

Legname asciutto							
IMPATTI	CICLO VITA						
	Produzione e trasporto dei combustibili	Uso finale dei combustibili	Energia di trasporto	Energia di feedstock	Istallazione nell'edificio e uso	Dismissione	TOTALE
Consumi energetici, MJ							
	2.11	5.14	0.27	15.61			23.13
Materie prime, kg							
Legno (50% acqua)							3.5
Acqua							0.257

	Produzione dei combustibili	Uso finale dei combustibili	Trasporto	Processo	Installazione nell'edificio e uso	Dismissione	TOTALE
Emissione in aria, g							
Polveri	0.1						0.1
CO	0.5	0.1					0.7
CO_2	462.4	17.6	0.2				479.0
SO_x	6.9	0.0					6.9
NO_x	2.4	0.2					2.6
Idrocarburi	0.8	0.0					0.8
Metano	0.2		11.7				11.9
Emissioni in acqua, g							
Tutte le emissioni sono dell'ordine del centesimo di grammo e quindi ritenute trascurabili							
Rifiuti solidi, kg							
Speciali assimilabili agli urbani (scarti del legno)			0.035				0.035

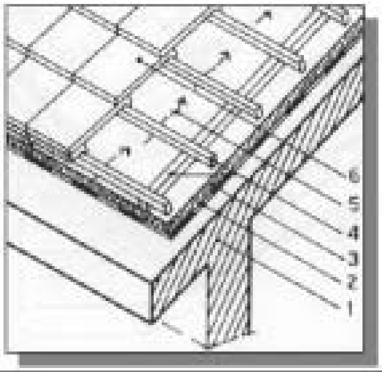
Fonte: BOUSTEAD, dati di media inglese, con riferimento ai rendimenti energetici italiani, 1996
Elaborazione: BOUSTEAD Model 4

picture 1

Data concerning different materials have been arranged in cards containing various roofing solutions, maintaining a common value of thermal insulation.

An environmental profile has been traced for the different typologies of civil and insulated roofs.

An example is in picture 2.



Soluzione

1. elemento portante: solaio in laterocemento
2. strato di schermo al vapore: foglio in PVC
3. elemento termoisolante: pannelli in lana minerale
4. elemento di supporto: listelli (0,05 x 0,07m).
5. microventilazione
6. elemento di tenuta: tegole in laterizio

Emissioni in aria (g)

Emissioni	*Valore*
Polveri	121757
CO	312
CO_2	94065
SO_x	623
NO_x	340
N_2O	-
HC (idrocarburi)	220
CH_4 (metano)	196
H_2S	0,4
HCl	4
HF	9,9
Organici	-
CFC/HCFC	-
CHO (aldeidi)	-
H_2SO_4	-
HCN	-
NH_3 (ammoniaca)	27
HC aromatici	-
Mercaptani	-
Cl organico	-
Altri organici	-
	-
VOC	0,2

Rilasci in acqua (g)

Emissioni	*Valore*
NO_3^-	-
NH_4^+	1
CN-	-
Fosfati (P_2O_5)	-
Altri nitrogeni	0,2
H^+	0,7
Solidi in sospensione	13066

Consumi energetici (MJ)

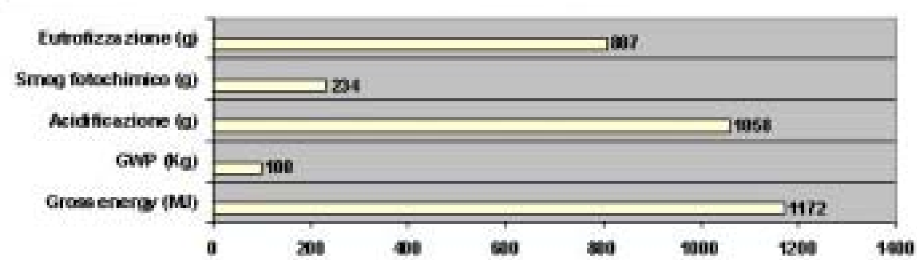
Combustibile	*Valore*
Elettricità	191,82
Oli combustibili	414,42
Altri combustibili	565,90
Totale	***1172,14***

Rifiuti solidi (kg)

Tipologia di rifiuto	*Quantitativo*
Speciali assimilabili agli urbani	-
Speciali non pericolosi	117,3
Speciali peric. e non pericolosi	4,2

Effetti ambientali

GWP_{100}	100,25 kg CO_2
Acidificazione	1058 g SO_2
Formazione di smog fotochimico	234 g C_2H_4
Eutrofizzazione	807 g NO_3^-



picture 2

Then results have been have been standardised and classified in 4 environmental effects:

- greenhouse effect;
- photochemical ozone creation;
- eutrophication;
- acidification.

This work has enabled the evaluation of potential help on the part of designers in the reduction of some environmental effects.

The first important result has been collecting data about building materials and all elements regarding their production, which in the future may be updated with other data.

Another important outcome has been the definition of an environmental profile for many types of civil and insulated roofs.

These results do not allow a definite choice between two different roofs, as selection depends on many factors and not only on environmental sustainability.

However, it is possible to work out a set of values for different roof typologies, suitable for vehicles or roof garden for example.

The final goal of this work has been to define a minimum and maximum range of release and energy consumption for different typologies of existing roofs.

The very conclusion of the dissertation resulted in the final comparison of the planning solutions of a building in progress with our set of values.

The building analysed for this case study was proposed by CSELT (Service Centre and Telecommunication Laboratories); from its roofing system, two significant indexes have been calculated: energy consumption in MJ and impact on the greenhouse effect. Once inserted in a tailor-made range, they assess the degree of environmental sustainability for the solution adopted.

For further information: tesqua@katamail.com