4.Building materials

Unlike all other living creatures, man has always to protect himself against nature by means of clothing and buildings. Apart from animal hides, building materials are the oldest category of materials used by man to maintain his existence, followed soon by weapons.

The traditional materials used in the developing world were by their nature more sustainable than most modern materials. Renewable or very widely available raw materials were used without elaborate or energy consuming processes, though frequent labour intensive maintenance was required. Modern materials often imply greater environmental impact, without necessarily assuring of better environmental quality. This rises the problems of comparing and assessing different types of variables.

The construction industry is a huge and increasing consumer of materials. Total materials “take” by all industries currently runs over 10 billion tons per annum, with construction responsible for around 80% of that amount. Construction uses a wider range of materials than almost any other industry, including metals, ceramics, plastics, natural materials such as timber and natural stones, etc.

Construction materials are not particularly high-technology types, neither are they expensive. Compared with other industries, the materials for construction are, in general, among the cheapest. They are not high embodied-energy materials.

Material	Embodied energy (MJ/kg)
Hard and soft woods	1.8 – 4.0
Concrete	3.0 – 6.0
Bricks	3.4 – 6.0
Stone	1.8 – 4.0
Cement	4.5 – 8.0

There are several aspects that must be taken into consideration when choosing building materials with regard to the sustainability:

- Limit use and reuse of building materials;
- The environmental impact of building materials;
- Use of residual products;
- The possibilities for recycling of the chosen materials;
- The durability of buildings and materials;
- The quantity of energy required for the production and the use of the materials.

4.1. Limit use and reuse of materials

The limit use of materials can be examined into two aspects:

- Limit the quantity of used materials and
- Keep the building materials in their own cycle as long as possible.

Limits the quantity of used materials can be achieved still at the design stage taking into consideration the real requirements of the dwelling and the dwelling environment. In many cases, the amount of paving can be reduced, the transport infrastructure can be optimized, etc. At dwelling level, prefabricated structures, measurement based on commercial sizes and improvement of the detailing can be implemented.

This medieval wall on the Greek isle of Poros was built many centuries ago from old mill stones and remains from ancient Greek temples.

Keeping the building materials in their own cycle as long as possible can be done on two occasions: during the design stage or demolition stage.

At the design stage a dismantable building system can be chosen, where all the elements and components can easily and directly be re-used after dismantling a building. This building system is called Design For Dismantling.

Design For Recycling is another building system where during the design stage reckoning is given to the fact what to do with the building materials after demolition. The materials are easy to separate during the demolition process and after further processing they can be used as a raw material for the production of building materials.

The second possibility is to do everything that is possible at the demolition site in order to improve the recycling of materials and elements. This is the most common solution nowadays, because the greater part of the buildings ever built, have never been built for dismantling.

In all cases, the detailing at the design stage is of primary importance for the reuse and the recycling of materials. Architect should limit the use of adhesive-bonded materials, paint, impregnating agents and coatings as much as possible, since the separation of these materials is problematic.

4.2. The environmental impact of building materials

When choosing building materials it is important to take into consideration their environmental impact. The environmental impact of building materials can be examined in two aspects:

- Harmful gas emissions during the processing of the materials and
- The availability of raw materials.

As it was mentioned above, modern building materials often imply greater environmental impact. In general, natural materials are preferred.

When choosing a natural material, it must be taken into consideration its availability. One of the causes for the global warming and climate change is the destruction of the primary forests. Following this, it is of primary importance to use only sustainably produced wood (from plantations). Another aspect of the availability is the damages implied on the environment during the extraction of raw materials, that is the reason why it is preferable to choose secondary (recovered) natural raw materials.

The choice of building materials with regard to their environmental impact is a very complex issue, but following are some general guidelines:

- Avoiding the use of environmentally harmful materials like: wood preservatives, low-grade materials (foamed concrete) to seal the ground, asbestos, red lead, products containing substances that damage the ozone layer (like clorofluorocarbons), chipboard with high formaldehyde emissions, preserved steel products in a dry indoor environment, galvanized steel used externally, etc.
- Preferring materials with low adverse environmental impact like: sustainably produced wood for timber-framed constructions, floors, roofs, window frames, kitchens and finishing materials; loam, mineral plaster, lime, gypsum, bricks, ceramic tiles for finishing, floors and walls; mineral wool, foamed glass, straw loam as insulation materials; ceramic, polyethylene, polypropylene for drains; steel gas pipes; linseed-oil based, water-based, boiled and mineral paint; natural stone; etc.

4.3. Use of residual products

The demolition of building structures produces enormous amounts of materials that in most countries results in a significant waste stream. This implies great impacts on the environment. One of the solutions to this problem is the use of the residual products from building demolition in new constructions. We can examine construction and demolition waste as “raw materials for recycling”. Residual products are materials, which in principle have positive value and are suitable for reuse after collection and treatment. After treatment, residual materials become secondary raw materials.

There are great possibilities for the use of residual products as secondary raw materials:

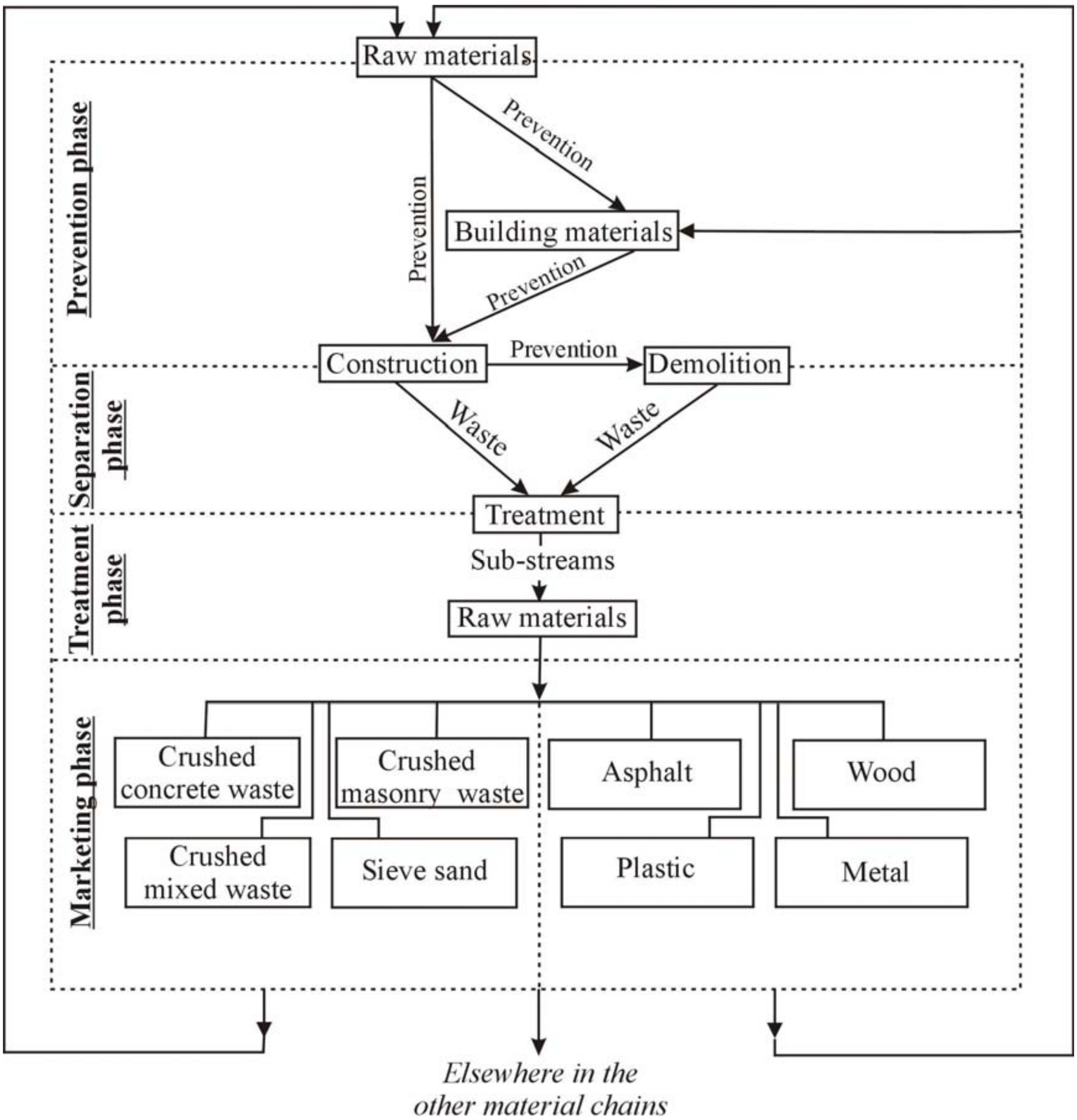
Potential replacement of primary by secondary materials:

PRIMARY MATERIALS	SECONDARY MATERIALS
Embankment sand	Sieve sand Recycled crushed sand Pulverised fuel ash Slag from waste incinerators Phosphorous slag sand
Concrete and masonry sand	Sieve sand Recycled crushed sand
Sand-lime brick sand	Sieve sand
Gravel	Concrete granulate Masonry granulate Mixed granulate Artificial aggregate Slag from waste incinerators Phosphorous slag
Crushed natural rock	Concrete granulate Masonry granulate Mixed granulate Phosphorous slag
Limestone or marl	Pulverised fuel ash Fly-ash from waste incinerators

4.4 Possibilities for recycling

Material reuse and recycling are not new phenomena. Waste materials such as metals, wood and paper have been reused since time immemorial. Opus caementitium (comparable to concrete), made of crushed rock, was commonly used in Roman times. The concrete structure used for transporting water from the Eiffel to Cologne contained a binder made with lime, dust from broken bricks and other substances. Concrete with crushed stones was used as an aggregate in 19th century Germany.

Recycling, collection, recovery and reuse are commonly confused terms. Often they are used as synonyms for "recycling", whereas in fact they have different meanings. Recycling is related to the full cycle of "new-old-new" and implies a series of operations: collection, dismantling, sorting, treating and subsequently returning to the original manufacturer, who again turns it into a "new" but secondary raw material. Occasionally, it is immediately made into a secondary semi-finished product.



Recycling refers to the entire cycle

Four concepts of particular importance in synthetic material recycling are:

- *Primary recycling*: recycling for the same purpose, e.g. asphaltic concrete road surface that is crushed and resmelted on site into a new road paving;
- *Secondary recycling*: re-entry into the cycle for a new purpose, e.g. reusing a road paving as a subbase for a new paving;
- *Tertiary recycling*: “breaking down” a synthetic product for the manufacture of another plastic, this is usually referred to as “depolymerisation”;
- *Quaternary recycling*: this is not actually recycling in the above sense. This term is used for the conversion of raw materials into energy, such as the incineration of synthetics or used paper, with energy generation.

4.5. Durability of buildings

Recycling of building materials is increasingly being considered as a viable way of reducing the environmental impacts of building. The energy benefits of recovering building elements for reuse or for recycling can be as much as a third of the total energy use of a building. Moreover, recycling and reusing building elements reduce depletion of natural resources and destruction of natural habitats and resulting extinction of plant and animal species.

However the scope for recycling building elements and materials in existing buildings is often limited by technical constraints imposed by the construction of the building itself. In order to maximize the potential for recycling in buildings in the future, buildings should be designed to facilitate the reuse and recycling of building elements and materials.

Here arises the question which buildings should be designed with regard to their durability and which with regard to a future dismantling.

In most European cities there are private and public buildings more than 100 years old. Building for durability still does appear to have a place in today’s culture. To determine where designing for recycling and designing for durability is most appropriate a survey was undertaken of UK architects to establish the nature, frequency and motivation for refurbishment, alteration and replacement work to buildings and building elements.

The results of the study show the following:

- The average frequencies of the work varied according to the type of the work, work to the building interiors occurring more frequently than work to the exterior, and according to the type of the building.
- Retail buildings, bars and restaurants were found to have the shortest turnover of internal fitouts and shopfronts and public buildings on the other end of the scale had the longest periods between interventions.
- Generally, the work frequencies were well below the potential life of most building elements.

CATEGORY OF WORK	AVERAGE FREQUENCY OF WORK IN YEARS
Decoration	7
Internal remodelling	10
Replacement of services	13
Replacement of external non-structural elements	29
Structural alterations, conversions and extensions	25

Average frequency of building work

BUILDING TYPE	FREQUENCY IN YEARS
Housing	20
Offices	18
Museums, community buildings	21
Healthcare buildings	14
Churches	80
Retail	5
Leisure	11
Bars, restaurants	4

Frequency of work to building elements of existing buildings

MOTIVATION FOR WORK	%
Maintenance	20
Statutory requirements	3
Increase economic value	11
Increase and improve use of space	30
Update to current technologies	5
Improvement of building performance	9
Improve appearance	16
Follow fashion, trends	6

Motivation for building wok

- It appears that the motivation for building work is significant. Most work to existing buildings was not motivated by requirements for maintenance, but rather by the wish to enhance the appearance, increase space or improve the economic value of the building.
- The building design should provide a durable structure that would allow changes of finishes, second building elements and services. It would also be designed to allow changes of building use.
- Services should be able to be dismantled and the components reconditioned or recycled.
- Finishes should be designed for reuse and recycling.

5. Water supply systems and possible measures for implementation of water saving systems

5.1. The importance of water saving measures

For people, the priority is to satisfy basic social development needs such as an adequate supply of food, shelter, and availability of potable water and access to health services and education.

Together with food and adequate shelter, water supply and sanitation are an immediate priority and vital not only for an improved standard of living but also for disease prevention. Solving people's water supply and sanitation needs using the most appropriate and efficient of a range of technologies will ensure that these vital services are supplied as widely as possible.

Global water consumption has increased seven-fold since the beginning of the 20^{th} century. Since 1950 water consumption has nearly tripled, from 1,365 cubic kilometres a year to 3,760 cubic kilometres a year in 1995. Water availability has declined dramatically, from about 16,800 cubic metres per capita a year in 1950 to 7,300 in 1995. Despite a more than doubling of the number of people with access to safe water since 1980, some 1.3 billion people still lack access to safe water and some 2.5 billion lack access to adequate sanitation. Polluted water is still a major cause for diarrhoea disease. Currently, 20 countries with 132 million people suffer from water scarcity, having less than 1,000 cubic metres per capita yearly, a benchmark below which lack of water is considered to constrain development and harm human health. It is expected that around 2050 mankind will reach 8,9 milliard people, but the resources of our planet will be the same.

In Europe, most people enjoy adequate supplies of fresh, clean water. But water resources are under threat of many human activities. Water depletion is becoming irreversible as a result of ground water over-pumping and aquifer depletion. Industry uses water in large quantities for cooling and cleaning. Agriculture uses water for irrigation.

In these conditions it is necessary to find adequate measures for water saving and for decreasing of water pollution and contamination.

In Agenda for action for Sustainable Development is shown that water and water sanitation are critical threats to health. The world goal is safe water and sanitation for all.

Access to water and sanitation for all can not be achieved by the state alone. There is a key role for the private sector to play in devising community - level solutions. Although the private sector can provide some service delivery and maintenance, only the state can ensure that access to infrastructure is made available to all.

Pricing that reflects cost reduces household water and energy use and the need for water treatment. It also raises revenue to create infrastructure for all.

Policy development needs a public – private participatory approach, involving planners and users, especially women, who play a central part in the provision, management and safeguarding of water supplies. Key measures include:

- A commitment to providing access to clean water and sanitation services for all, with special emphasis on reaching rural and peri-urban areas;
- Demand management with pricing that better reflects the cost of water, improving agricultural and industrial efficiency of use;
- Investments in infrastructure to cut leakage and extend coverage to all households;
- Community participation in devising solutions and setting up local water services.

5.2. Possible water savings measures at urban development level

Water supply systems depend on water sources and the requirements of the consumers.

In function of the consumers' dimension the water supply systems include:

- Various water sources;
- Infrastructure which ensures the transport and the distribution of the potable water;
- Consumers' installations;
- Infrastructure which ensures the evacuation and the treatment of the polluted water.

In each part of these systems there is possibility to loose water and it is necessary to adopt special measures for decreasing of the losses, with positive impact on the services' prices.
The following measures ensure the water saving:

- An efficient project for water supply systems;
- A normal operation and maintenance of water supply systems;
- Price covering the costs (investment, operation and maintenance);
- Real measurement of the water used.

It is important to emphasise that water saving determines the energy saving in each part of the water supply systems. So will the energy consumption for water pumping and for water treatment decrease.

At the urban development the following measures can ensure water savings:

- Closed water system in district;
- Encourage infiltration of rainwater into soil;
- Water purified with help of plants;
- Separate sewerage systems (rainwater does not go to sewage works).

The technical – economic studies will decide the adopted measures taking into consideration the local conditions, the consumers' requirements, etc.

5.3. Possible water saving measures at dwelling level

From the annual energy balance for a medium flat in Bucharest can be concluded that energy for pumping of potable water needed yearly in medium flat represents 1% of the total energy consumption. So, it is necessary to save water at dwelling level taking into consideration the availability of potable water and the energy saving.

At dwelling level, it is necessary to ensure the correct measurement of the water used and that consumers pay the correct price for water. The real expenditure determines the care of the users for water saving. So, it is necessary to use separate water meters in each dwelling.

The water saving measures are the following:

- The achievement of water installation with modern equipments which permit the flowing of water only during the real activity of washing;
- The correct maintenance of the water installation which avoid water losses;
- Educational programmes for water use.

In present there are the following solutions for water savings:

- Toilet unit with flush interrupter;
- Water – saving toilet unit (6 litres per flush);
- Toilet unit with adjustable flush (6 – 9 litres);
- Water – saving toilet unit (no more than 4 litres per flush, e.g. Gustarsberg system);
- Bath or shower water ("grey water") used to flush toilet;
- Taps with flow limits (30 – 50% less water per minute);
- Water – saving showerhead.

It is possible to use rainwater for washing machine, for shower, for watering plants, cleaning, etc.