

# **RECYCLED CONCRETE - ECOLOGY AND ECONOMIC CRITERIAS**

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*Recycled concrete is a relatively new technology in the production of concrete, and as such it requires careful approach. Only proper scientific research and proven professional guidelines should govern the development of this technology. Recycling of this material, which is the symbol of construction today, becomes not only technical innovation, but also the needs of modern urban society. The paper presents basic ecology and economic criteria about use of recycled aggregates in concrete production. Some advantages of these materials are also presents. An accent is given to that we need to start thinking about our environment.*

*Keywords: Ecology, economy, recycled concrete, environment*

## **INTRODUCTION**

Mankind has entered into another millennium. All the time of the people existence on Earth mankind evolved, their needs were changing but some things human civilization carries with it since its creation. Construction is one of those things. Always in history, it was the same needs. Adapt to the environment and adapt environment to itself. Technology evolves, the science moves forward, and each time brings previously unseen ventures. Engineers have greater opportunities, knowledge, techniques and materials. Construction power has always been tied to the degree of development of society and its material capabilities to meet the needs of improving living conditions and economic.

Today, at the beginning of the 21st century, it is undeniable that the concrete was the main construction material of the twentieth century and is likely to remain and the beginning of this century. In the world literature data on the time of creation of first concrete are not harmonized. In English literature it is accurately states that the oldest concrete was found on the territory of our country, in the famous archaeological site Lepenski Vir, age 7600 years ago, around 5600 BC.

Modern concrete industry requires continuous development of new technologies and materials. Lack of natural aggregates in urban areas and the growing distance between sites and concrete plant imposed the possibility of replacing natural aggregate with recycled materials.

Another very important aspect that refers to the

use of recycling in the concrete industry is overburdened landfills. Concrete wastes can not be compacted or further processed, not subject to chemical nor biological degradation. And it has also extra long life time. It placed him in the group of materials with high level of burdening on the city landfills.

Recycled concrete is a material that can successfully merge economic and environmental interests. Therefore it gives safe and proper way to improve technologies that will be supported by economists and ecologists together.

## **ENVIRONMENTAL ASPECT**

Today civil engineers around the world face the problem of attitude towards the environment. The technological power of people has become so large as to threaten the man himself as part of the environment in which he lives. Every builder in the future will have to set himself clear ethical question - whether what builds enhances environment. And most importantly - whether projects they leave behind may adversely affect the health of people, but also nature. EU countries in terms of legislation and in practice have gone furthest in terms of protection and improvement of the environment. The Netherlands puts this principle in the first three priorities of the state. The new view of the world around, but also the problems of urban life inevitably bring the recycling process in the concrete industry.

In urban areas, construction waste disposal problems increased. The reasons for the demo-

lition of existing buildings are many: changing their purposes, aging buildings, reconstruction of the urban fabric, natural disasters (earthquakes, fires, floods), wars and so on. Construction waste makes up a large part of the solid waste. Because of its density characteristics it can not be compacted, and on the landfill it occupies a large space. If landfills are closer to the city we have lower transport costs but it occupies urban construction land and violates aesthetic and sanitary quality of the city. If its are away, transportation costs rise enormously. Certainly uncontrolled management of construction waste leads to pictures that unfortunately in all major cities in our country can be seen.

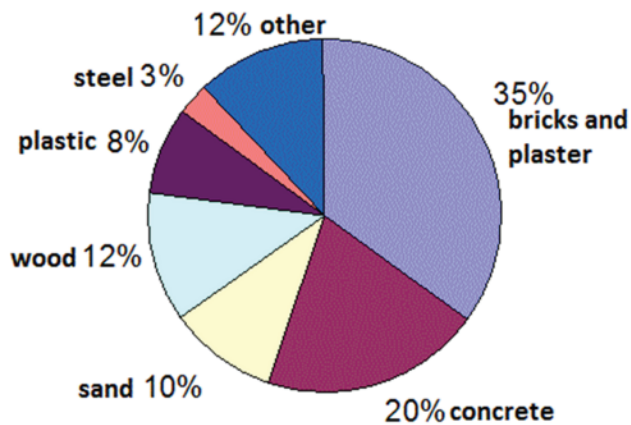


Figure 1: Mash of demolish materials of construction

Figure 1 shows that 55% of the material can be reused in concrete structures./2/ Re-use of materials reduces costs simultaneously on several levels: Transport costs of waste materials, the costs of removal and disposal, as well as short-

ened the transport of materials for new buildings. But from an environmental point of observation of the problem still the most important effect is reduced of pollution.

Recycling is actually one of the aspects of waste management. As soon as quality control of waste management is introduced and grows, very quickly in time we will notice decrease of contamination . (3)

**ECONOMIC ASPECTS**

In order to start investment projects with recycled concrete, the use of new types of concrete must be economically profitable. Environmental benefit will not, or will very hard convince investors to use concrete with recycled aggregates in certain projects.

Those are the advantages that can bring use of this type of aggregate to companies that will use it in the concrete production:

- 1) Abundant and constant source of demolished materials in urban areas
- 2) The possibility of obtaining aggregates free of charge
- 3) Usually locations of demolished materials are closer to the factories of concrete than natural sources of materials
- 4) The possibility of works parallelization, ie. company engaged in the demolition project use construction waste as a raw material for another project
- 5) Education about global trend of using recycled materials in the construction industry, to be prepared for potential projects abroad.

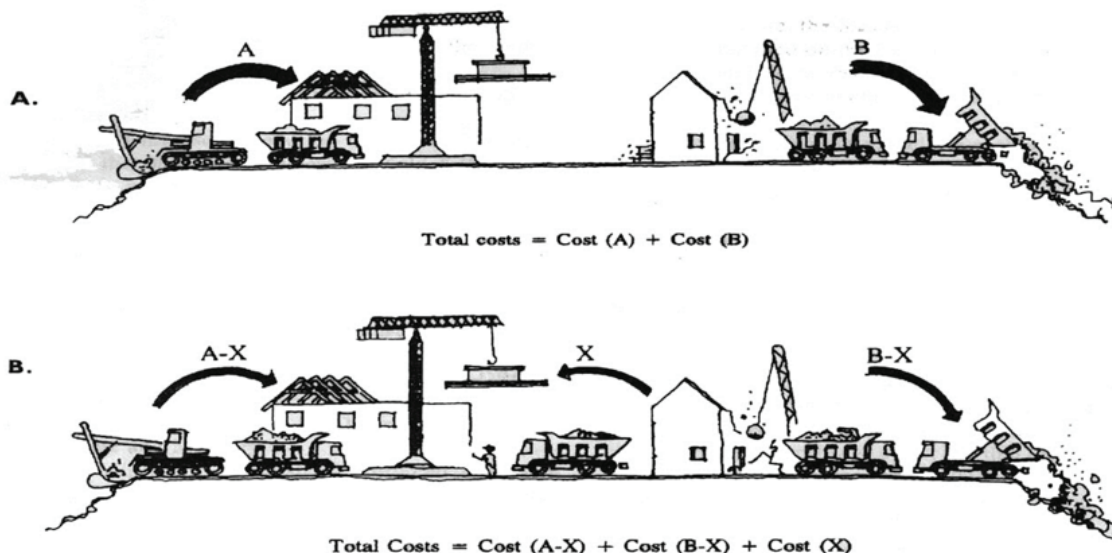


Figure 2: A – traditional model of building and demolishing B-process of recycling in building and demolish

Figure 2 presents two approaches to building demolition. In the model A total cost - UC consists of the price of natural materials and transport - A and cost of transportation and disposal of materials - B.; In model B, X is the price of recycled materials. Total cost for model B is given also:

A.  $UC = A + B$   
 B.  $UC = (A-X) + (B-X) + X$  (4)

The economic model shows that the optimization of prices will depend on: the price of demolition, transport costs, the price of recycling, labor costs and the price of natural materials.

Research studies have shown that the production of concrete with recycled aggregates is most cost-effective in the case of parallel recycling of other materials and simultaneous clearing the ruins.

Cost-benefit economic analysis are made mainly in countries where there is a regulations for the use of this type of concrete (USA, Netherlands,

Scandinavian countries and Japan). Their experience has shown that the greatest savings are in areas where the natural aggregate is inaccessible (and therefore also expensive). It is also proved that the most effective start of recycle concrete production is in urban areas, where it is a certain source of demolished concrete. Especially with the constant tendency of shortening the lifetime of buildings. In urban areas with a population of more than half a million, the annual available amount of demolished concrete was several hundred thousand tonnes. For economic reasons, therefore, recommend place to set up central concrete plant working with recycled aggregate is in the vicinity of large cities, preferably close to the sanitary landfills, in order to achieve the savings on transportation.

Table 1 provides a comparative overview of the total cost of natural aggregate and recycled aggregate.

Table 1: Total cost of natural aggregate and recycled aggregate

| NATURAL AGGREGATE  | COST              | RECYCLED AGGREGATE   | COST              |
|--|-------------------|--|-------------------|
| Cost of excavation   | $N_1$             | Extra treatment of demolish material at the site   | $S_1$             |
| Cost of production   | $N_2$             | Price of demolition pieces (negative)  | $S_2$             |
| Cost of external transport   | $N_3$             | The cost of transport demolished pieces to landfills (negative)                                | $S_3$             |
| Cost of internal transport   | $N_4$             | The cost of transporting the pieces to the production site                                     | $S_4$             |
|  |                   | The production of recycled aggregates  | $S_5$             |
|  |                   | The cost of transporting recycled aggregates to the construction site or to the concrete plant | $S_6$             |
|  |                   | Additional cost of control, storage and sales  | $S_7$             |
| TOTAL  | $\sum_{i=1}^4 Ni$ | TOTAL  | $\sum_{i=1}^7 Si$ |
| The main requirement for the competitiveness of recycled aggregate $\sum Si < \sum Ni$ |                   |  |                   |

It is expected that the price of recycled aggregates will decrease in the future, especially once the initial phase of development of production technology would be finished. But it is expected the price of natural aggregates would increase. As natural aggregate is less available, price will be higher, and in parallel, transport cost will grow because sites will be farther away. So even though the condition is not met at the moment, it does not mean that the use of recycled aggregate is not economically justified.

### CONCLUSION

Concrete is increasingly becoming a large load to utility systems of cities. The only substance that people use more than concrete is water. Every year, one ton of concrete is produced per inhabitant of the planet Earth (Goldstein, 1995). What we must always bear in mind is that the concrete material and all materials have limited service life. After the expiry of the service time it has to be removed and disposed of in landfills. Stricter requirements for waste management and increasing price of waste disposal will help to launch a completely new approach to construction and demolition waste. Concrete at the end of their life cycle, can become raw material for new projects.

Recycling of this material, which is the symbol of construction today, it becomes not only technical innovation, but also the needs of modern urban society.

Recycled concrete is a relatively new technology in the production of concrete, and as such it requires careful approach. Only proper scientific research and proven professional guidelines should govern the development of this technology. The reason is that without it we can get a bigger problem than it is a concrete waste itself. Bad quality of recycled concrete can cause damage and shorten the service life of buildings. This will be followed just with a new tones of demolished materials.

Many objects that we demolish today were built a long time ago, when concept of recycling was unknown. Buildings of nowadays must be adapt to a future light construction demolition and recycling.

The manufacturing process of recycled concrete then very begins with construction of a standard concrete. High quality standard concrete, will one day give high quality recycled concrete.

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