USING PET (POLYETHYLENE TEREPTHALATE) WASTE FOR BUILDINGS

MUNTEAN Radu*, CAZACU Christiana,
Transilvania University of Brașov, *e-mail: radu.m@unitbv.ro (corresponding author)

ABSTRACT
The work presents some efficient solutions for using the plastic bottles waste (PET) in construction field. For some reinforced concrete elements like monolithically cast reinforced concrete plates, savings in concrete quantities can be achieved by executing gaps with lost formworks made by PET. As well, there are presented some proposals for making mattresses, composed by attaching the plastic bottles, intended for execution of thermal-insulations for buildings and some other efficient solutions for reuse the plastic bottles waste. The presented solutions have the advantage that they try to resolve the public society concern regarding the protection of the environment against pollution (in this case, pollution with hardly degradable materials - plastic bottles).

Keywords: plastic bottles, construction elements, pollution

INTRODUCTION
The polyethylene terephthalate (PET / PETE / PETP or PET-P) was invented in 1941, being initially used in the textile industry. As regards the production of packages for drinks, it started being used in the ‘70s. The rapid development of the production for a series of products (especially agri-food ones), as well as the imposition of certain hygiene rules as regards their manipulation and preservation, have led to increasingly perfected disposable packages, especially made of plastic.

MATERIALS AND METHODS
PET, a plastic from the family of polyesters, is nowadays being used mainly in the food industry, for packing soft drinks, mineral water, milk, oil and other types of products (fig. 1).

Apart from the multiple advantages these packages exhibit, there is also a series of disadvantages, among which the great waste volume subsequent to the use, and especially the difficulty to reintroduce them in the natural circuit, as they are not biodegradable.
The environmental problems the PET raises are paramount, considering that, once thrown away in the open (fig. 2), the plastic bottle degrades over hundreds of years. Although the material is cheap, the price we pay for using “plastic bottles” on a large scale is extremely big: over the recent years, the quantity of plastic waste randomly left in nature has increased significantly. The PET is not biodegradable and resists for hundred of years, bringing important prejudices to the environment.

Because of this, the recent years have seen an attempt to find as efficient as possible solutions for recycling this waste or for using them in other fields, so as to lessen the prejudices brought to the environment.

Such a field is that of constructions, generally speaking, an example being represented by the use of plastic bottles waste for executing structural walls in buildings to replace the traditional bricks, which would ensure both the necessary structural resistance and an efficient thermal protection.

The present paper also presents some other construction elements for whose execution plastic bottles (PET) can be used; the solutions proposed have the great advantage that they welcome the society’s desire to protect the environment against pollution (in this case, pollution with hardly degradable materials – plastic bottles), but they also have benefits for the construction element itself (by reducing its weight).
The first solution proposed resides in the execution of reinforced concrete elements [1], which could spare concrete by executing gaps [2] with irretrievable formwork made by plastic bottles. In addition, there are some propositions for producing mattresses, by attaching plastic bottles, intended for the execution of thermal-insulations for buildings.

1. **Possible solutions for using PET bottles**

At national and international level, there have been different attempts for exploiting this waste, at higher or lesser costs, all being primarily aimed at the reduction of environmental pollution.

Using the present paper, the author brings forth a possible use of some types of plastic packages – larger or smaller bottles – for executing certain construction elements.

The first construction element for which such packages can be used is represented by reinforced concrete plates which are monolithically cast [3].

According to the type of package used, there can be executed plates with circular, rectangular or square gaps.

In what follows we present some of these solutions:

a) floor with circular gaps on two directions (fig. 3);

b) “boxed” floor with flat underside (fig. 4)

![Fig. 3. Floor with circular gaps](image)
As a rule, monolithically cast reinforced concrete plates [1], [3] have a full and consistent section on their entire surface. This has the disadvantage of a big weight as compared to the actual load it has to support (g > p), which leads to an additional amount of reinforcement aimed at taking over the force of its own weight [4], [5].

In the case of some of the precast floors, the intrinsic weight has been successfully diminished by making gaps (e.g. precast strips with circular gaps) or by executing frames which have led to rational forms (caissons, \( \pi \)-shaped roof elements etc.) [2], [6].

For the monolithical plates, the application of such solutions is difficult and expensive to accomplish, given that the respective frames can no longer be used. Because of this, we consider that, using a series of plastic bottles as lost shuttering, gapped plates can be executed whose weight is smaller, and so the concrete steel consumption is reduced.

The interconnection of the bottles can be made using adhesive tape or joints made of plastic bottles again, by sectioning their body. In addition, coupons made of steel, wood or other even cheaper materials can be used for joining the bottles’ thinner parts [4].

Another element which can successfully use such bottles is represented by ceiling, porch or boarded floor insulation (fig. 5) [7], [8].

For executing insulations, we consider it efficient to have mattresses obtained by joining bottles coated in a thermo-contractile film. Thus, a thicker or thinner air layer will be obtained according to the bottle shape, which is a known thermal insulator [9].
Fig. 5. Thermal insulation mattresses

These mattresses can be easily handled and will be placed on the concrete plate of a porch or between the wood beams roof of an attic; thus we have a better and cheaper thermal insulation than using classical insulation materials (polystyrene, mineral wool etc). They can also be used on the sand and ballast of a cold bottom board (concrete), placed directly on the ground, thus obtaining an appropriate thermal insulation [10].

The mattresses described above could represent a solution for obtaining walls and roofs meant for provisional buildings placed on camping sites organized for events that need to host a greater number of people (e.g. pilgrimages).

The PET bottles can also be used for executing transparent / semitransparent walls and roofs for agricultural production greenhouses, as they ensure both an appropriate illumination and thermal protection, successfully replacing glass or plastic films which are currently used.

Another possible use of PET bottles resides in the solar panels for warming up water. They can be built by joining the bottles in an air-proof system and by pacing it on the roof of the house. By connecting this panel to a water source, we can ensure its warming by means of solar energy, which is a “green energy”, thus contributing to the reduction of the fossil fuels consumption and the diminishment of emission of the green house effect gases (CO₂).

Tanks for dissipation of rainwater into the soil. By using high capacity bottles (5 l - 10 l) bound together with adhesive tape and perforated to allow passage of water, can make homes for water catchment from build surfaces (roads, platforms, buildings). After capture, the water slowly dissipates into the soil. Currently there are solutions such as using
Using PET (Polyethylene Terephthalate) Waste for Buildings

Perforated plastic blocks that are installed like ceramic blocks and are designed specifically for this.

If filled with sand or any other granular material which should confer PET bottles rigidity, they can be partially buried in the ground, thus constituting alleys. Thus, the plates and slabs made of concrete or other materials are replaced, which spares material and costs. At the same time, by alternating different colour bottles, also “artistic” effects are possible or even special architectural models.

A field close to that of constructions, that of interior design, finish and decorations, can also benefit from the PET bottles waste.

By joining plastic bottles under the form of mattresses or packs, constituent elements for beds, stools, tables can be obtained, on top of which textile materials, wood or metal can be placed to complete the picture.

By clipping parts of the bottle body, one can obtain different types of lamp shades, lampions or other artistic elements for decorating the house or the Christmas tree.

Even the plastic bottles bungs can have an ecological use by threading them to form decorative curtains.

The aforementioned solutions have the following advantages:
1. The reduction of the total quantity of PVC waste which should be recycled via traditional methods, with the corresponding costs and reduction in the environmental pollution.
2. The reduction of the quantity of concrete necessary in a structure, with an impact on its total weight, and, thus, on the improvement of its behaviour as regards earthquakes [2].
3. The reduction of the physical effort, considering the smaller quantity of concrete which needs to be handled.
4. The improvement of the thermal insulation performances of the concrete plates, due to the air gaps [9].
5. The reduction of the consumption of reinforcements under the form of spacers (frames) for the reinforcements in the upper part and the decrease of their „walk over” risk, which could lead to the incompliance with the project position [3].
6. Executing thermal insulations for porches (bottom boards) and even walls with relatively small costs as compared with those necessary for classical materials (mineral wool, polystyrene, etc.).
7. Due to the fact that bottles and films do not absorb water, the thermo-insulation properties do not change as a result of an accident (soakage and wetting of the insulating layer) [7].
8. The reduction of the quantity of wood, steel, glass or other construction materials, by their partial replacement with PET waste [4], [5].

9. The reduction of the quantity of the plastic newly introduced on the market, by re-using PETs under the form of construction or finish elements, thus reducing the quantity of raw material (petroleum) and the energy necessary for producing plastic.

Among the disadvantages of the solutions proposed, we enumerate:
1. The necessity to collect bottles in an organized, civilized and selective manner, with the support of cleaning firms.
2. The need to have quite a significant storage, sorting, assembling volume for plastic bottles.
3. The increase in the manual labour costs on the building yard, because of the time necessary for assembling the bottles.
4. The increase in the transportation costs because of the big volume of low-weight material.
5. The need to adopt calculation methods which are different from the existing ones, especially for crossly reinforced plates.

CONCLUSIONS

The author has the conviction that the solutions proposed are valid and that they are relatively easy to implement. In the future, details will be provided regarding calculations and the structure of the elements presented.

REFERENCES

2. AVRAN C-TIN, s.a. (1979), Proiectarea economică a elementelor din beton armat, Editura Facla.
7. SIKA ROMANIA, Construction (case studies, design, examples, theories, information system).
8. NP 060 - 02 Normativ privind stabilirea performanțelor termo-higro-energetice ale anvelopelor clădirilor de locuit existente, în vederea reaibi-litării și modernizării lor termice (Buletinul Construcțiilor nr.18 -2003).
USING PET (POLYETHYLENE TEREPTHALATE) WASTE FOR BUILDINGS
