# FEASIBILITY STUDY ON THE USE OF LIGHTWEIGHT CONCRETE WITH EPS (EXPANDED POLYSTYRENE) IN CIVIL CONSTRUCTION

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Abstract:

*The civil construction sector is considered one of that more pollute the environment because it generates a huge amount of waste in their processes. Lighter structures and more rational cause the final price of the buildings become smaller and thus more accessible to lower income population. One solution in the optimization of structures and the application of new materials to the concrete (since it generates large costs in a work) makes this goal is reached. Therefore this study aimed to assess the resistance of concrete to compression using EPS (expanded polystyrene) as added by replacing the gravel, giving lightness, economy and flexibility to structures. It was found that for some applications their use and possible, following the standards prescribed in the regulations.*

Keywords:*Expanded Polystyrene, Civil Construction, New Materials.*

## INTRODUCTION:

The use of lightweight concrete in construction presents a large variety of applications. For the manufacture of lightweight concrete are various materials available in the market, the most used and aim of this work is the EPS (Expanded Polystyrene), also known as Styrofoam. This material has gained a stable position in the construction industry by being an insulating material, lightweight, sturdy and easy to handle, in addition to its relatively low cost.

In 1949, chemists Fritz Stastny and Karl Buchhoz discovered in the laboratories of BASF in Germany Expanded Polystyrene (Styrofoam). Being a hard plastic cell, the result of polymerase styrene in water, not in its manufacture uses CFC and no other substitute for their gender. Contains in its composition pentane (Hydrocarbon), which in contact with the sun's rays deteriorates rapidly, and can be recycled back to the condition of the raw material. The EPS beads containing 3 mm diameter which are subjected to expansion, and may have its size changed to fifty (50) times the initial through steam. The beads are composed of 2% (two per cent) of polystyrene and 98% (ninety-eight percent) of air.

In 1968 there was a prediction that the lightweight concrete would have a great importance in the construction industry, it presents a number of advantages over conventional concrete (cement, sand and gravel). The lightweight concrete can be achieved with high quality standard anywhere in the world, being an easy molding material, which greatly facilitates architectural designs. Mixed in mixer (cement, sand and the polystyrene beads) is then molded in forms. Your transportation is simple, using wheelbarrow or truck bomb, like a conventional concrete. Since it is a lightweight material, there is a great ease in handling.

The EPS beads serve as fillers and must bein corporated into heavier elements (sand and cement), so as to obtain a concrete with better resistance after curing. In the process of implementation of lightweight concrete, the percentage of expanded beads are between 60 and 70% (sixty and seventy percent) of the volume of concrete and the

rest is mixed by the structure of concrete, decisive percentage of cement consumption. The lightweight concrete material has decisive percentage of cement consumption. The lightweight concrete material has low thermal conductivity, does not allow external heat spreads to the internal environment, or that is transferred to the internal external, ensuring thermal comfort construction. Furthermore, its versatility in being molded in various sizes and models is another big advantage. Further, it has low water absorption, therefore, does not retain moisture. World consumption of Polystyrene is 500 t / y to the United States, Germany 250 t / y, Japan 225 t / y and Spain 70 t / y. Currently in Brazil use of this material divided by 45% in construction, 42% in industrial packaging, and 13% in consumer articles. A major problem in the modern world is the large amount of garbage

produced daily by men and despised, often directly into the environment. Among these wastes, we can find the EPS, which can be easily reused (Siqueira et al. 2004).

One may grind and the EPS blocks used in constructing self-supporting panels and for construction of housing (Figure 1 and 2).

Figure 1 and 2: Houses built with Paines made from concrete with addition of EPS.

The EPS is applied concrete in various types of buildings, such as:

- Pre-made;
- Internal sealing elements(walls);
- Acoustic Insulation;

- Thermal Insulation;
- Insulating thermal and acoustic slabs;
- Resistance to spread of fire;
- Exterior Walls without charge;
- Pre-fabricated houses;
- Bricks or blocks of light weight concrete;
- Elements hollow lightweight concrete.

The lightweight concrete comprising EPS due to its characteristics should not be used in structures requiring very large efforts. Therefore we can use this material in the following applications: One structural adjustment of slabs in general (slopes for drainage); closing panel sand concrete block (Building rated home), pre-fabricated elements (pillars and tiles for walls); Flooring among other applications. In this work aims to use correctly and effectively the lightweight concrete, should conduct studies on compressive strength of this material for your different traits to compare the findings with the values recommended by the standard, verifying the possibility of its application in buildings.

## MATERIALS AND METHODS:

All as says were performed by following the recommendations of the Brazilian norms, described below:

- NBR 7215 (1997) - Portland cement - Determination of compressive strength.
- NBR 5739 (2007) - Concrete - Compression test of cylindrical specimens - method of test.
- NBR 5738 (2008) - Concrete - Procedure of molding and curing of concrete test specimens.

The bulk density of the lightweight concrete EPS (Styrofoam ®), varies between 400 to1600 Kg/ m³according to the application need. During tests performed in

laboratories cementations materials was used density ranging between 700 and 1600kg/m³, which is done in mixer. For the particles do not float on water due to its lightness, it was necessary to apply an adhesive soluble in water, this assay was used to glue white. All materials were purchased in local market. The mixture was made as follows: First: Was dissolved in the water-soluble adhesive, observing the proportions of the mixture; Second: The lay-up EPS (Styrofoam ®) mixer with a little cement, selected as needed; In third: With mixer setting motion up the adhesive diluted in water; Fourth: When the cement has begun to set in EPS (Styrofoam ®), placed alternately the rest of cement, sand and water; Note The residence time in the mixer was enough for the mixture to reach the required consistency for launch. By using vibrators is necessary to take care that do not separate the elements of the mixture, since the EPS (Styrofoam ®) be a light weight material.15 moldings were made for each trace indicated in Tables II, III and IV, and these were broken to 7,14 and 28 days for analysis. Thus we selected five samples of each density to rupture in seven days, fourteen, and twenty-eight days days (Figure 3, 4 and 5).

The proportion of the different components of the mixture for each density tested below in Table I, these values are derived from the literature reviewed for this test.

Table I –Composition of the mixture of lightweight concrete with EPS according to their densities.

| **Density** (kg/m³) | **Quantity Styrofoam** (Liters) | **Cement** (kg) | **Sand** (Liters) | **Water** (Liters) | **Adhesive** (Kg) |
|---|---|---|---|---|---|
| 700 | 1093 | 390 | 118 | 155 | 2,0 |
| 800 | 1015 | 390 | 186 | 165 | 2,0 |
| 900 | 942 | 400 | 243 | 175 | 2,0 |
| 1000 | 873 | 400 | 311 | 180 | |
| 1100 | 809 | 400 | 382 | 180 | |
| 1200 | 742 | 390 | 466 | 178 | |
| 1300 | 678 | 390 | 537 | 178 | |
| 1400 | 615 | 385 | 613 | 177 | |
| 1500 | 553 | 380 | 689 | 175 | |
| 1600 | 487 | 375 | 764 | 175 | |

Figure 3: Body of Proof being pressed.

Figure 4: Body of Proof being pressed.

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Figure 5: Body of Proof after pressing process

RESULTS AND DISCUSS:

After the process of manufacturing the cylindrical test specimens, they were placed on moist healing, because one should keep the concrete completely covered with water or immersed to avoid causing them to evaporate, to be thereafter severed in accordance with the number of day (7,14 or 28), the results of the breakages done in the laboratory of the cementitious materials UENF in tables II, III and IV and according to the respective means are designed to examine graphs of the results (Figures 6, 7 and 8)

Table I - Results of breaks the mold to 7 days.

| Proof Body 1 | Proof Body 2 | Proof Body 3 | Average Value | Nominal Density (Kg/m³) | Resistance (Mpa) |
|---|---|---|---|---|---|
| 1.13 | 1.09 | 1.21 | 1.14 | 700.00 | 1.46 |
| 1.53 | 1.41 | 1.25 | 1.40 | 800.00 | 1.78 |
| 1.89 | 1.85 | 1.81 | 1.85 | 900.00 | 2.36 |
| 1.92 | 2.15 | 2.05 | 2.04 | 1000.00 | 2.60 |
| 3.06 | 2.87 | 2.88 | 2.94 | 1100.00 | 3.74 |
| 3.52 | 3.84 | 3.68 | 3.68 | 1200.00 | 4.69 |
| 3.87 | 3.91 | 4.00 | 3.93 | 1300.00 | 5.00 |
| 4.22 | 4.36 | 4.09 | 4.22 | 1400.00 | 5.38 |
| 4.58 | 4.49 | 4.52 | 4.53 | 1500.00 | 5.77 |
| 4.71 | 4.74 | 4.80 | 4.75 | 1600.00 | 6.05 |

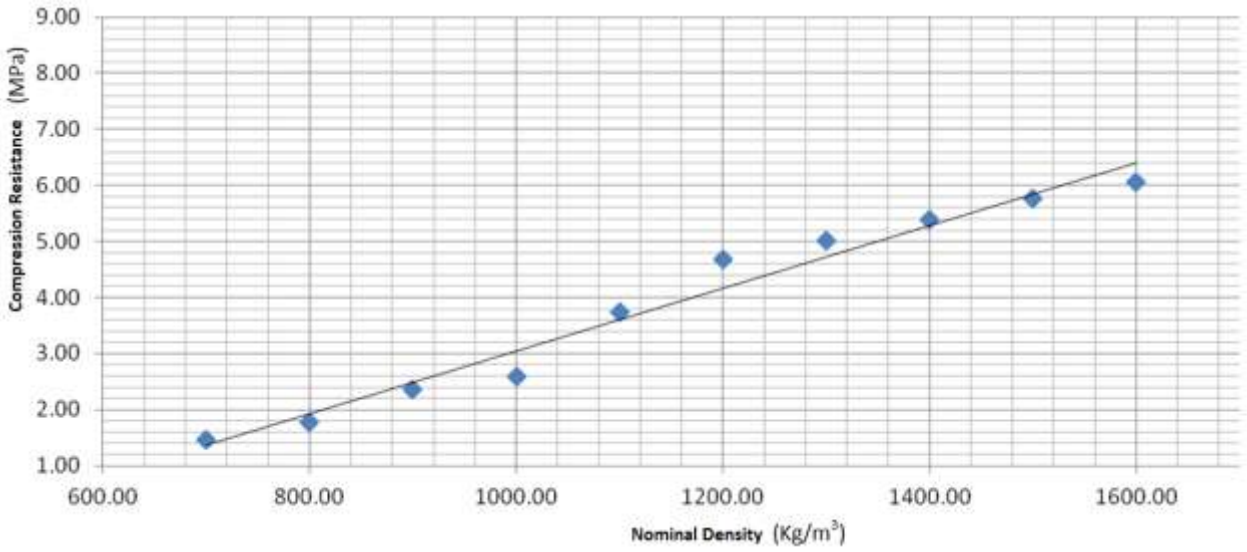


Figure 6: Graph of the resistance simple compression molds for lightweight concrete with EPS at 7 days.

Table II - Results of breaks the mold to 14 days.

| Proof Body 1 | Proof Body 2 | Proof Body 3 | Average Value | Nominal Density (Kg/m³) | Resistance (Mpa) |
|---|---|---|---|---|---|
| 1.45 | 1.46 | 1.51 | 1.47 | 700.00 | 1.88 |
| 2.02 | 2.06 | 1.98 | 2.02 | 800.00 | 2.57 |
| 2.18 | 2.13 | 2.10 | 2.14 | 900.00 | 2.72 |
| 2.76 | 2.83 | 2.69 | 2.76 | 1000.00 | 3.52 |
| 3.13 | 3.21 | 3.15 | 3.16 | 1100.00 | 4.03 |
| 4.32 | 4.55 | 4.51 | 4.46 | 1200.00 | 5.68 |
| 4.86 | 4.92 | 4.94 | 4.91 | 1300.00 | 6.25 |
| 5.22 | 5.21 | 5.18 | 5.20 | 1400.00 | 6.63 |
| 5.42 | 5.43 | 5.51 | 5.45 | 1500.00 | 6.95 |
| 5.98 | 6.01 | 6.03 | 6.01 | 1600.00 | 7.65 |

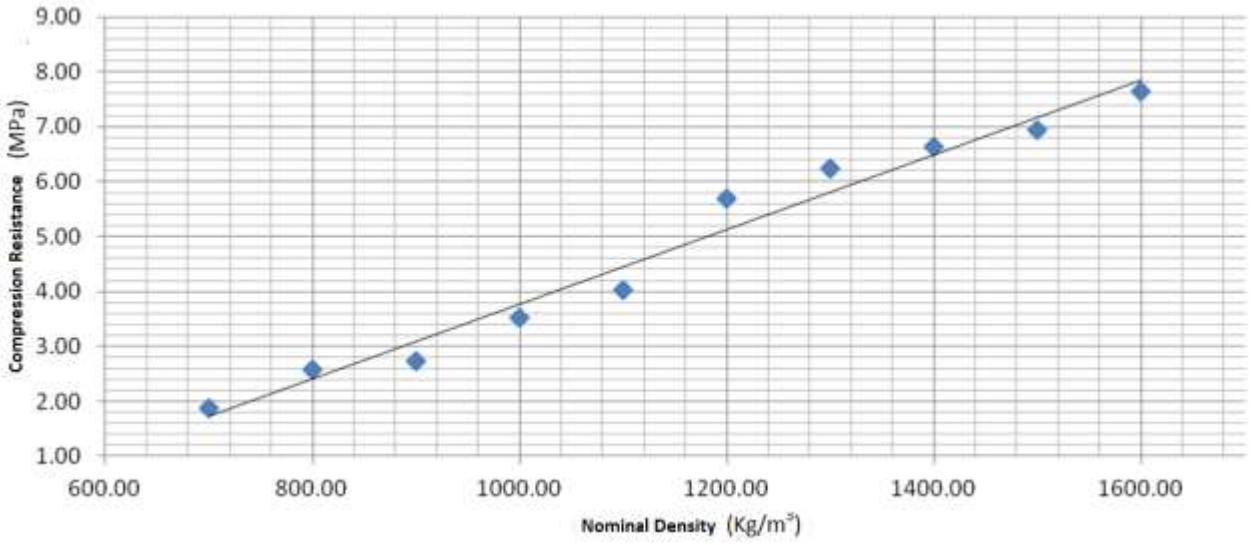


Figure 7: Graph of the resistance simple compression molds for lightweight concrete with EPS at 14 days.

Table III - Results of breaks the mold to 28 days.

| Proof Body 1 | Proof Body 2 | Proof Body 3 | Proof Body 4 | Average Value | Nominal Density (Kg/m³) | Resistance (Mpa) |
|---|---|---|---|---|---|---|
| 2.10 | 2.05 | 2.06 | 2.08 | 2.07 | 700.00 | 2.64 |
| 2.32 | 3.28 | 2.29 | 2.31 | 2.55 | 800.00 | 3.25 |
| 2.58 | 2.67 | 2.47 | 2.41 | 2.53 | 900.00 | 3.23 |
| 3.24 | 3.13 | 3.32 | 3.16 | 3.21 | 1000.00 | 4.09 |
| 3.62 | 3.76 | 3.79 | 3.83 | 3.75 | 1100.00 | 4.78 |
| 5.12 | 5.21 | 5.32 | 5.28 | 5.23 | 1200.00 | 6.67 |
| 5.60 | 5.73 | 5.72 | 5.67 | 5.68 | 1300.00 | 7.24 |
| 6.01 | 6.13 | 6.08 | 6.04 | 6.07 | 1400.00 | 7.73 |
| 6.32 | 6.37 | 6.39 | 6.41 | 6.37 | 1500.00 | 8.12 |
| 6.93 | 7.01 | 6.92 | 6.95 | 6.95 | 1600.00 | 8.86 |

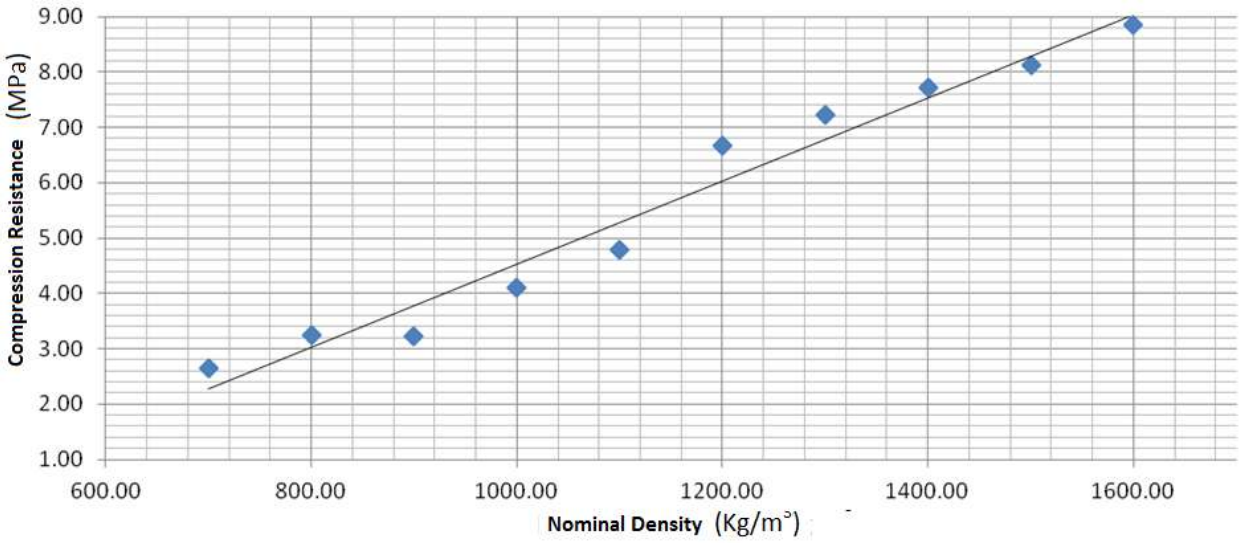


Figure 8: Graph of the resistance simple compression molds for lightweight concrete with EPS at 28 days.

CONCLUSIONS:

According to the mean values in test specimens molded at 7, 14 and 28 days, one can make an analysis of these values with the application in which this concrete with addition of EPS can be used as the maximum values found were 8.86 MPa they do not fit in concrete for structural use, in which the second NBR 6118/03 recommends a minimum strength of 20 MPa (C20), so it is recommended that the concrete with addition of EPS is used in applications where strength is not required for loading.

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