Use of recycled materials in bricks

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Abstract. In our presentation we are trying to clarify possibility of adding recycled materials into bricks and to name the changes of characteristics of individual additives. When we remind that the first ceramic decorative figure was The Venus of Věstonice. Babylonian gardens, Hagia Sofia, one of the most beautiful churches that has ever been built. The great Wall of China – The biggest brick creation in the world, medieval castle Malbork built in northern Poland not far from Gdansk’s bay which with its size resembles small town, skyscraper Chrysler Building in New York. All of these buildings have one thing in common and that is material from which they were built. After obtaining this knowledge, we have known for 10.000 years. Many types of modification of full bricks followed. Then the advancement ensued.

1. Introduction
In order to create brick products it is necessary to use proper material. Namely brick clay, brick loess, clay slates, clay-sand materials.

Shapable raw materials are divided according to the content of typical clay minerals and according to the method of weathering at the sediment depositon site (Table 1).

### Table 1. Granulometric of clay soil

| Granulometric of clay soil          | 1. clays | 2. dusts | 3. sands |
|-------------------------------------|----------|----------|----------|
| d< 2 . 10⁻⁶m                        |          | d € (2 ; 50) . 10⁻⁴m | d € (0,05 ; 2) . 10⁻³m |
| Clay                               |          |          |          |
| dirt                               | (≥ 50% clays) |          |          |
| dust                               | (20% 50% clays + 50% 80% dusts) |          |          |
| sand                               | (< 20% clays + > 30% dusts) |          |          |
|                                     | (< 20% clays + > 50% sands) |          |          |

If necessary it is also possible to divide different ratios of fractions appearing in the raw material according to the ratio (d-grain). (Table 2)
Table 2. Clay Soil

| Clay soil                        | Not strengthened | Kaolins, clays, anorganic pigments |
|----------------------------------|------------------|-----------------------------------|
| montmorilithic                   | bentoviny        | clay, shale, clay slate           |
| illithic, chlorithic, montmorilithic, kaolinithic | Non-strengthened | dirt, lime clays, marls          |
|                                  | strengthened     | Dirt, clay                         |

a) Non-formable materials, which alter the behavior of other materials during their creation process, drying and firing. These affect characteristic of the product up to micro space of fired product. Among these materials is counted several types of sediments up to industrial waste such as fly ash, slags, dregs and different types of sawdust.

We divide these amorphous raw materials into:

Slags: which affect the ductility, drying and firing behavior (deformation, sintering and shrinkage). Lightening agents: which reduce the bulk density of the fired shard, either directly after firing, thus the number of popres is increased, or indirectly by the composition of various types of raw materials. Fluxes: which are substances which form a given melt at a temperature which is lower than the firing temperature. This is achieved by adding easily fusible substances, such as feldspar, trachyts, pegmatites, various glasses. Optionally various oxides: CaO, MgO, FeO, K2O, Na2O.

2. Brick materials

Today’s manufacturers in the Czech Republic achieve a maximum strength of P25 (min 25N/ mm²) Higher or high strenghts are required for some vertical structures. [3] Even today we can find great amount of use for bricks with high firmness on vertical structures. These are load-bearing pillars for raised balconies, load-bearing walls for storing high-stress ceiling structures, elevator shafts and similar. As can be seen, the standard does not provide for such products, but products with extreme strenghts do exist. I am thinking of products that achieve a compressive strenght around P100 (min 100N/ mm²). Products offered by the last Prague brick factory of Štěrboholy, which thanks to a unique raw material (illitic slate), a well-chosen technological process and a method of processing, is the only manufacturer that produces such products. [1,2] (Unique, firmest full bricks in Czech Republic 2020 autors: Ing. Jan Fiala, doc. Ing. Milan Mikolaš PhD., Jan Fiala jun., Ing. Miroslav Lapka

Typical brick material has volume weight of 1450-1700 Kg/m³. In extreme cases we can come across such a raw materials which have volume weight of 2100-2300 Kg/m³. Each of these materials has its specific usage. For the creation of insulation bricks the bricks with considerable amount of lightweight additives such as sediments, paper-producing sediments, sawdust, coal dust. All of these materials are used for lightening of the future products thus increasing the insulation of product characteristics. Most of these additives burn in the furnace, in the product some microspaces can occure, weight volume will not change to the values about 750-950 Kg/m³. Material loses part of its firmness. Use of another additive is unreal.

These are materials suitable for production of bricks for peripheral and inner loadbearing vertical construction.

For the creation of acoustic bricks, brick material of weight 1650 – 1900 Kg/m³ is used. In extreme cases we can meet even with raw materials which have weight volume of 2100 – 2300 Kg/m³. There is a rule: The heavier material, the better are the values of measured sound resistance which range from 57 – 59 db¹. To produce such bricks, relatively low amount of recycled material would have to be used, but the exact ratio would be given only after the results from examination and following testing by accredited laboratory. [3]
For creation of full bricks which are used for peripheral a inner load-bearing and nonload-bearing vertical.

Construction of employment is visible, but only with magnesium materials and no other. Tyto These raw materials are ideal for the option of adding recycled materials into brick products. The additives will have impact on the strength, which will decrease about 50%. Due to extreme firmness of these products on average more than 60 Mpa, then adding about 30% of recycled material the product will have firmness of 30 Mpa, which will still leave it at the maximum limit 30 MPa, which is set by standard EN 771-1 for full bricks (Figure 1). [4]

![Figure 1. Full brick, sample A with content of 30% recycled materials Photo: (Ing. Jan Fiala)](image)

3. Conclusion
The problem of recyclation in brick products is solvable and the product can be utilized in practice. The character of recycled materials which is added to the bricks, together with the production technology, is a very marginal condition for the resulting properties of the bricks. It is important for simple compressive strength, but also for other characteristics that determine the properties of bricks and its use in building structures.

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