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Slip-resistant surface treatments with recycled container glass utilization

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Summary

Problem of the article is aimed at the construction completing period of bridge structures, whereas research of suitable slip-resistant surface treatment for bridge sections (i.e. where it is demanded or appropriate). Contribution of the research performed within the paper is glass based secondary raw material utilization on the surface treatment preparation. An optimal secondary raw material selection was performed in consideration of previous research (paper Slip-resistant surface treatments on bridge construction walking areas – the first stage), where the influence of recycled cathode ray tube glass was investigated. The secondary raw material (concretely recycled container glass) was then applied in suitable specific proportion and grain size to prepared matrix (epoxy resin). In the next phase of the research basic physical and mechanical properties determination of the prepared mixtures was carried out, i. e. tensile strength by rip off test by another name standstill to bedding.

KEYWORDS: macromolecular, surface treatment, container waste glass.

1. INTRODUCTION

One of the reasons why we are trying to exploit alternative materials is the environmental issue, lowering of consumption of natural materials and in the same time use of by-products from different productions. A problem of mankind approach to waste or secondary raw materials utilization in assorted industries has been becoming still more topical. That is not else even in civil engineering, whether in case of bulk cargo bridge elements production or minim final works. With regard to fact, that building materials industry is one of the largest excrements producers and one of the hugest energy consumers, tendency of secondary raw materials utilization and together with it a depression of current technologies energy intensity is rising. Obviously, at the same time, these facts have to be

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necessarily showed in economical point of the problem, which acts very important part too.

2. EXPERIMENTAL STUDY

Composite is a material system, which is compound from two or more phases. The scale shows properties, which were not possible to attain by simple summation of single constituents. One of the simplest composite types is a binary system compound from matrix and filling agent. In our case the macromolecular-based matrix was used, concretely epoxy resin. With regard to its excellent parameters and output product required final properties the phase was not modified. Attention was focused on only modifying the filling agent. It was necessary to find such SR material, which occurs in suitable quantity and has not another significant usage in other industries. Important criterions at evaluation were composition and microstructure of the material.

2.1. Container glass pre-treatment

For purposes of the paper, recycled container glass was used. Substitution of required fractions was modified only by sieve analysis. There has carried out previous research on possibility of use of this materials and according to obtained results two fractions has been selected: 0,25 – 1 mm a 1 – 2 mm. These were used in part as filling agent as well as fill, whereas their combinations were seemly applied too.

Figure 1. Recycled container glass before the pre-treatment

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2.2. Preparation of samples

As binders there has been selected epoxy resin material due to its high adhesion to any material. Fairly special two components system of epoxy resin with commercial name – Lena P102 was used for the experimental work. Fractions of glass have been prepared prior to application of selected glass fractions to fresh mixture of both components epoxy matrix partly as filling agent and partly as spreading. Thereby procedure an emphasis was posed first to slip-resistance, physical, mechanical and chemical (durability) of final substance. View of constitutors' percentage substitution of particular specimens is obvious from Figure 2. Ad interim only two types of base course mechanical properties were investigated, namely concrete pavement and ceramic tile. In to the future among others a steel ground is considered. Immediately after the preparing test specimens the tensile strength determination by pull-out test according to appropriate standards was carried out. Steel discs of 50 mm in diameter were used for the determination. Test apparatus Dyna matches standard demands, i.e. makes possible to set up tensile strength (adhesion) with an accuracy of two decimal places, without any computation necessity.

2.3. Samples' characteristics investigation

One othe most important properties to be tested was tensile adhesion test (sometimes called rip off test) The test is proceeded so that disc dislocation is considered at first, their fastening on investigated surface treatment (by two-component special adhesive) is following. After the adhesive curing the discs are trimmed on eight sides (octagonal shape). In the next stage the tensile strength determination is carried out by means of afore mentioned apparatus. Place of failure registration is very important at testing. This puts us valuable information about the surface treatment physico-mechanical parameters. It is not suitable, if a failure on ground and surface treatment interface occurs abreast with low strength value (i.e. less than 1,5 $N \times mm^{-2}$). This verity is already predicating about insufficient adherence of the material on ground.

2.4. Obtained data evaluation

Graphic evaluation of average strength values was performed for easier orientaiton and result comparing. This is showed on Figure 1. in this paper there are presented only average values (corrected values) due to clearness charts. The average value is counted from 4 independent measurements.

Tests have been carried out on four different substrates:

- Concrete block (thickness. 50 mm) – sample No. 1, 2, 3, 4, 5,

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- Ceramic tile (thickness. 5 mm) – sample No.. 6, 7, 8,
- Steel plates (thickness. 4 mm) – sample No. 9,
- Vibro-pressed Cetris plate (cement wood composite - thickness. 12 mm) – sample No. 10, 11.

Two types of fractions of crashed glass were available for testing as fillers 0,25 – 1 mm a 1 – 2 mm. Ratio between filler and binder- polymer epoxy resin in shown in the chart in figure 1. Amounts are in percents with expressed values of pull off strength in N/mmm^2. (rest of volume to 100% is the amount of epoxy resin, which is different in every mixture).

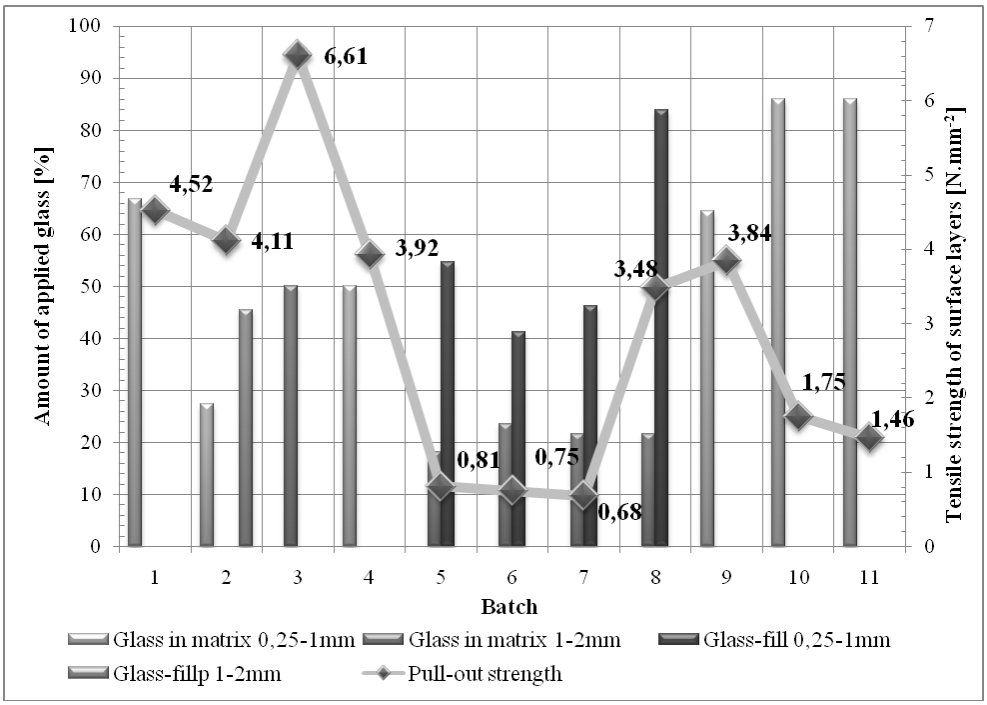

Figure 2. Expression of influence of pull-off strength on samples of particular types of polymer coatings (axis Y left), different types of substrate (axis X) and pull off strength (axis Y right).

Classification of particular places of break-off:

- Break-off in surface material – P
- Break-off in boundary layer between substrate and surface treatment – R
- Break-off in surface treatment (coating) – EP

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Places of break off at different test samples:

- 1, 3 – P
- 2 – ½P a ½EP
- 4 – EP
- 5-11 – R

Figure 3. Representative sample where 67 % of fraction 0,25 - 1 mm was used (on concrete block of thickness 50 mm)

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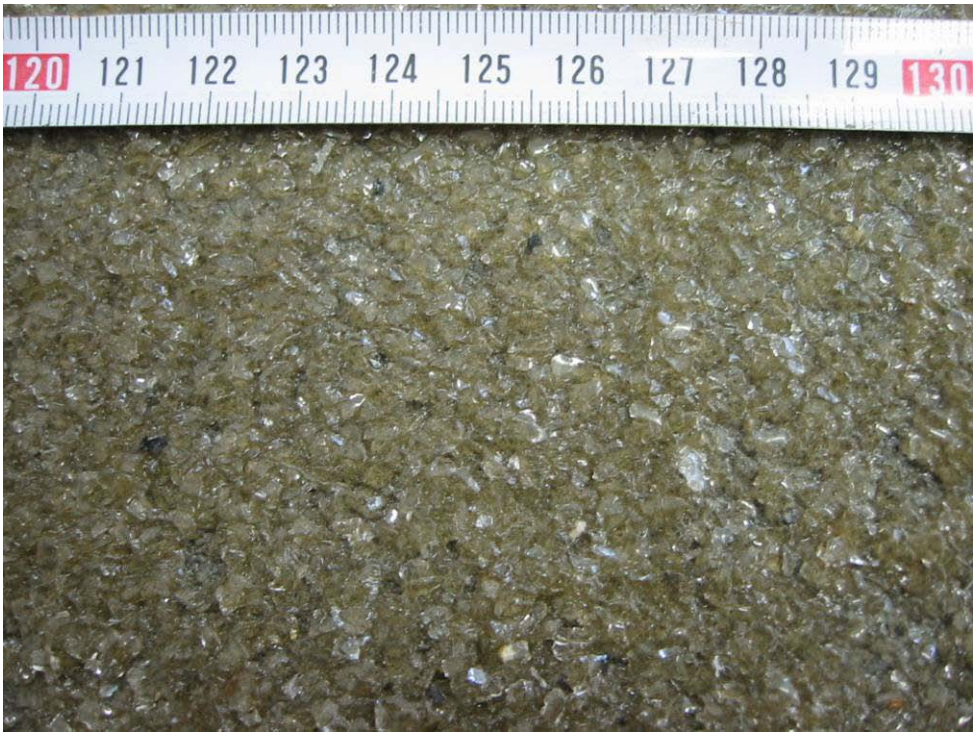

Figure 3. Representative sample where 50 % of fraction 1 - 2 mm was used (on concrete block of thickness 50 mm)

3. CONCLUSIONS

Research described in this paper was focused on influence of by-products as fillers to polymer coatings. Main task was to develop coating material with comparable properties to normally sold products. Paper describes assessment of suitability of by-product for such purpose. Mentioned by-products were two fractions of crashed glass collected from public containers. Altogether 4 types of polymer coatings were tested on four types of substrate; concrete, ceramic, steel and composite cements wood plate.

It is possible to state, that according to test results, it is possible to use developed coating for all tested surfaces. The pull-off test, which crucial property in hardened state had excellent values on all substrates even without primer penetration which normally used on starved surfaces.

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Due to its fillers have these coatings special properties as resistance wear and anti slip off properties. Due to all mentioned properties it possible to use as final surface treatment of concrete floors, steel staircase, bridges etc.

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