EXPERIMENTAL EVALUATION OF THE LOAD BEARING CAPACITY OF GLASS REINFORCED PLASTIC BUFFERS UNDER IMPACT LOADING

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Very strong and wear resistant composites are used with great effect in parts of many heavy-duty structures [1-3]. This made them very interesting from the point of view of using them as buffers in the driving of reinforced-concrete piles. The problem is complicated by the fact that the design of the buffer has to ensure high productivity of the pile driver, i.e., it must be sufficiently elastic, have high strength and wear resistance, but low transverse rigidity. Besides that, the buffer has to be able to “restore” damaged places, the damage being due to punctures by protruding reinforcement at the end faces of the piles. The buffers used at present in the USSR and other countries [4-6] do not satisfy all three requirements. They have a comparatively short life, do not ensure good efficiency of the pile driver, and do not protect the pile heads from damage. On the basis of the suggested model of the design of buffers made of modern materials [7] we obtained satisfactory results but if such buffers are to be widely and effectively used, their geometric, technological, and structural parameters will have to be studied more thoroughly.

The main task of the present work is to establish the geometric and structural parameters of glass-fiber buffers that are optimal from the point of view of their service life. We chose four arrangements of spatial reinforcement (Fig 1), and also a laminated structure based on satinized fabric. The binder was resin EDT-10. By these arrangements we made specimens for studying under laboratory conditions their strain, elastic, and strength properties mainly in the transverse direction.

The stress-strain curves in the direction of the z-axis for the five investigated types of composites are presented in Fig. 2. The level of the elastic behavior of the composites depends substantially on the arrangement of reinforcement. Laminated materials, and also materials made by arrangement c, exhibit elastic behavior at stresses not exceeding 80-90% of the rupture stresses. For composites reinforced by the other arrangements the limit of elastic behavior is considerably lower. This applies particularly to the behavior of the composite made by arrangement d which is characterized by great nonlinearity at stresses exceeding 50% of the rupture stress, and by a comparatively short linear part of the stress-strain curve. It should be noted that the stress-strain curves of all the investigated materials in tension and compression are identical (Fig. 3).

There are also noticeable differences between the plastic properties of the materials under consideration (Table 1). Laminated material has the highest rigidity, transversely as well as in the direction of reinforcement. Slightly inferior in this respect is the spatially reinforced material made by arrangement b. The composite reinforced by arrangement d has the lowest rigidity in the direction of the z-axis. The composite reinforced by arrangements a and c (see Fig. 1) has a modulus of elasticity transversely that is close to the mean between the modulus of elasticity of the laminated structure and material based on arrangement d. On the other hand, these arrangements ensure a high shear modulus (see Table 1).

An analysis of the data on the strength properties of the investigated composites (Table 2) shows that the materials reinforced by arrangement b have the highest compressive strength in the transverse direction. This arrangement can also attain high compressive and tensile strength in the direction of the x- and y-axes. Table 2 shows that other arrangements do not yield good strength indices simultaneously in all the three principal directions. For instance, arrangement a of reinforcement entails low strength properties of the reinforcement in the direction of the x-axis but comparatively high compressive and tensile strength can be attained in the direction of the z-axis. The composite made by arrangement c is somewhat inferior in compressive strength transversely to the composite reinforced by arrangement a but it is considerably superior to it in strength in the direction of the x-axis. The composite with laminated structure has good tensile and compressive strength properties in the direction of the x-axis and compressive ones along the z-axis. Its substantial shortcoming is low tensile strength in the direction...
Fig. 1. Arrangements of reinforcing the investigated glass-reinforced plastics: a, b) formation of a system of two filaments with rectangular disposition of the fibers in the direction y for $\theta = 36^\circ$ (a) and 19° (b); c) three-dimensionally reinforced with alternating straight and curved fibers in the direction of the x-, y-axes; d) spatial disposition of the reinforcement.

Fig. 2. Compressive stress—strain diagrams in the transverse direction of glass-reinforced plastics: 1) laminated on the basis of fabric TS-250/3; 2-6) spatially reinforced, made by arrangements b (2); c (3); a (4); d (5, 6) according to Fig. 1 with loading in the direction x.