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THE USE OF THE FIBREGLASS AT THE REINFORCED CONCRETE ELEMENTS

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The main constituents of the reinforced fibreglass concrete are: the glass fibres, the binder, the sand and the water. In order to change certain characteristics there can be used different types of additives or fillers.

The fibreglass is used in the shape of beams and cords having the lengths comprised between 12 and 15 mm; the cutting is realized with different devices, which are designed, built and used by variant firms. The reinforced fibreglass concretes use the following binders: *hydraulic binders* – based on Portland cement, like the normal Portland cement, the Portland cement with additions, the fast-hardening cement (in Romania the RIM), the white and coloured cements; the alumina cements; *non-hydraulic binders* – the burnt plaster, the magnesite cement, clay.

When using the hydraulic binders based on Portland cement, the fibreglass has to be resistant in an alkaline medium, so it is usually used the AR-type of glass. For the other types of binders (the alumina cement and the non-hydraulic binders) the choice is usually for the normal glass fibres type E.

In the case of the reinforced fibreglass concretes the role of the sand is to reduce the drying out contraction of the cement stone, therefore to reduce the cracking risk. The maximum size of the sand granules is not supposed to be more than 7 mm, because these granules can destroy the fibreglass and reduce their productivity. Pilkington Cem-Fil recommends the use of cherty sand with 96...98% SiO_2, maximum size of 1 mm and no more than 10% of granules smaller than 0.15 mm. Before the use the sand needs to be washed.

In the specialized literature, the reinforced fibreglass concrete is defined as the mixture in which the maximum diameter of the aggregate is 7 mm, while the reinforced fibreglass cement is a mixture of cement, water and fibres, as well as a mixture of cement, water, fibres and/or sand with the maximum size of 5 mm. In order to facilitate the understanding of the reader, the present study will use the expression "reinforced fibreglass concrete" (FGC) both for the proper concrete as well as for the reinforced fibreglass cement.

The additives are used to improve some characteristics of the fresh or hardened material. Thus, as plasticizers additives for the improvement of the workability and the reduction of the W/C ratio, there can be used the methylcellulose, the polyethylene oxide, and, in our country, the calcium lingo-sulphonates (LSC) in proportion of 1...2% from the binder's quantity. Also, based on the nature of the binder, there can be used cement hardeners as well as retarding admixtures, air entraining agents, etc.; their utilization, within certain boundaries, can be done based on lab researches. When preparing the reinforced fibreglass concrete there can be also used different fillers, like: ash, grinded volcanic tuffs, perlith, etc.

The fibreglass content in the mass of the concrete (mortar) varies in different proportions, accordingly to the properties that have to be realized. The down to date practice showed that the optimum percentage of fibreglass integrated in the concrete is of 5...6% in its mass, respectively 4...5% in its volume; the result is that $p_g = (1.25...1.30)p$.

The integration of the fibreglass in the concrete and the mixture of the constituent materials can be done using several different procedures: spraying, pre-mixing, wrapping or throttling; the last two methods are applied for the reinforcement with continuous fibreglass.

The spraying is the most used procedure and the result is a high quality product. This method is applied by using either a manual sprayer or an entire mechanical system.

The manual spraying is the most used method at present. The main element of this system is a gun that concurrently sprays into the frameworks both the cement mortar (paste) and the fibreglass. This device also contains a mixing machine where the cement mortar (paste) is prepared, which is then pumped with compressed air up to the atomizing nozzle of the gun. The glass fibres, wound on a bobbin, are overtaken and cut by a device placed on the same gun; the fibres are cut short on the desired length. The rates of the cement paste and that of the fibreglass are adjusted in order to obtain the fibres content from the project (approximately 5...6% in mass). The productivity of a single manual device is about 10...12 kg fibreglass concrete each minute or 2.5 t in eight hours, which suppose a 50% work time usage.

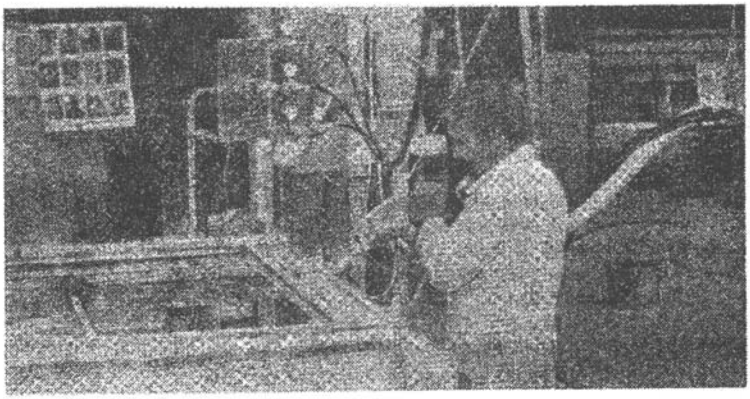

Fig. 1.- Aspect on the usage of the fibreglass spray gun.

Fig. 1 represents an instance of the usage of the spray gun. A manual spraying device needs a four-member team (one who is spraying and the other three who are preparing the mixture, the casings and the form stripping); the minimum space needed for the fabrication is 1,000 m^2 (the proper work-space, the preparation of the casings and then the form stripping, the concrete treatment, the storage of the basic material, etc.).

When manufacturing the FGC elements by the spraying procedure there have to be verified the spraying rate of the constituent materials, the sizes of the realized products, and the fibre content on test tubes sampled from the executed products.

The FGC products are kept in their forms for one day, after which they are kept in a high humidity medium for at least six days.

The manual spraying procedure is advised for elements with different horizontal or vertical profiles, like the facing panels.

The mechanized spraying is recommended for plane elements or thin profiles. A mechanical unit has a cross frame on which stays the spraying device for paste and fibres; the patterns, installed on rollers or on a plate conveyer, are passed through the cross frame. The material distributor is adjusted so as to ensure a uniform mixing and a right distribution of the fibres.

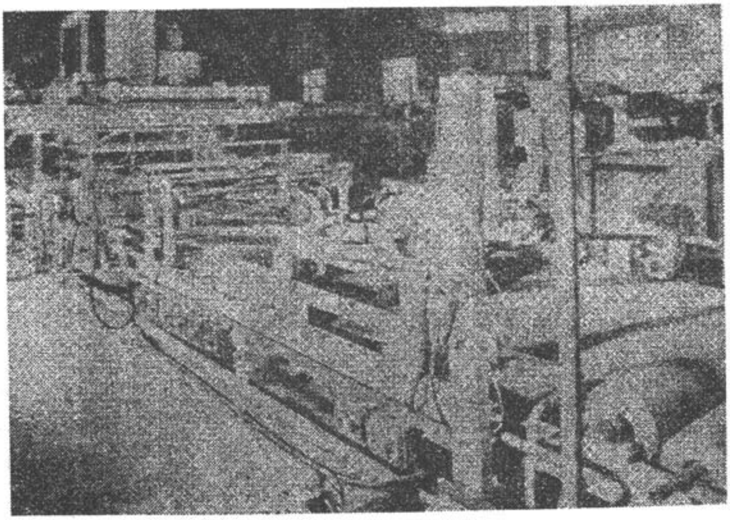

Fig. 2.- A general view of the device used for the mechanical production of FGC.

These products contain a high quantity of water, representing a plastic mixture, which will consequently be exposed to vacuum, as in the case of the cement-asbestos products. The equipment for these procedure consists of a continuous filter belt, on which there are atomized the materials from the spraying set. The resulted elements pass over a vacuum-realizing box, which eliminates the products'water excess. The finishing and cutting of the elements is realized on the fresh product. A mechanical device for the production of the FGC elements is presented in Fig. 2.

The pre-mixing technology is based on the admixture of cement, sand, fibreglass and water in a blunger or a concrete mixer; the outcome paste is then worked following some steps: pouring, compressing, injection, centrifuging and extrusion; there also can be used the climbing shuttering (laminar ones). There are used plasticizers additives in order to make the mixing and working easier and to reduce the ratio water/cement.

The pouring procedure in open forms is used for elements that do not require high resistance, as windows, hotchpotches, fences, etc. Vibration is used for the concrete's compacting, the occluded air elimination as well as for the finishing of the surfaces.

The pressing of the cast elements ensure that the water excess is removed, rending them a high mechanical strength and an almost immediate form removal. The mixture's composition and the press are conceived to ensure a fast elimination of the water excess. Fig. 3 presents the inside technology of obtaining the FGC elements by pressing, in England. This method is applied to small size elements.

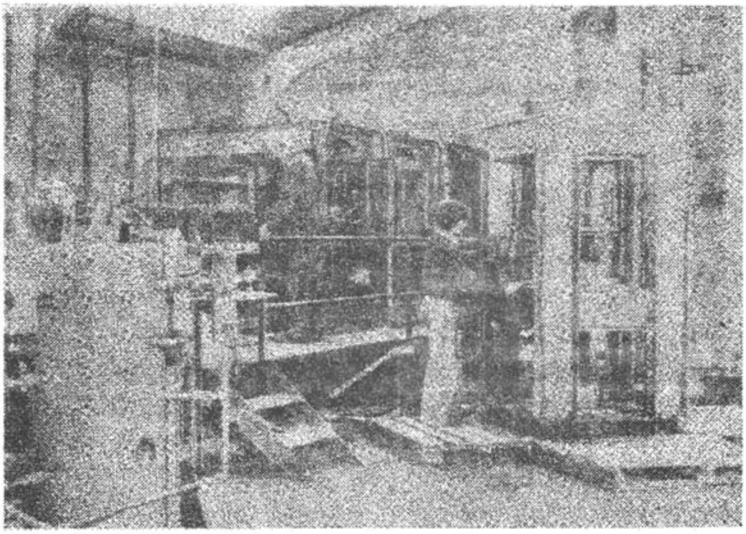

Fig. 3.– Aspect of the units used for obtaining the FGC elements by pressing.

When using the climbing shuttering method, the paste is poured from a near-by set chute into the casing. The chute is supplied with material from the hopper, which has a vibrator on its top. This method is applied in order to obtain either thin bi-dimensional elements or linear profiled elements. Fig. 4 presents a climbing shuttering unit realized in England.

The injection, centrifuging and extrusion of the pre-mixed paste are realized following the same methods as for the normal concrete.

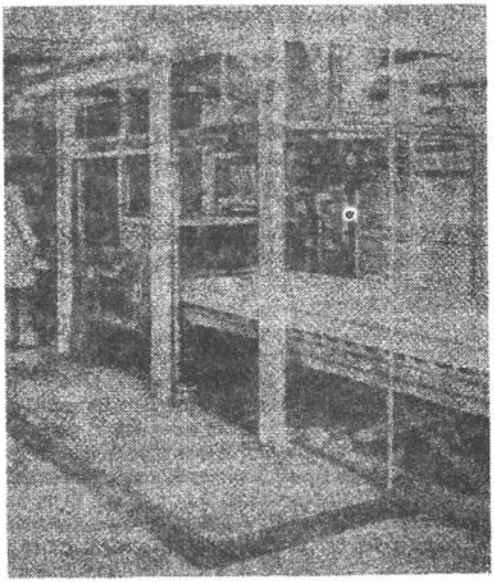

Fig. 4.- Aspect of a unit that uses the climbing shuttering method to produce FGC elements.

Members from the Reinforced Concrete and Buildings Department at the University Politehnica, in Timişoara, used the pre-mixing technology, realizing at the same time some technological tests to integrate the fibreglass by spraying, using devices attained in their lab. They used fibreglass of 30...45 mm length and 4...8% of mass reinforcement, PZ 400 cement and aggregate with the maximum size of 3 mm, sorted in two fractions; this mixture contained one part cement and two parts aggregate. As plasticizers it was used the calcium lingo-sulphonate (CLS) and it was reduced the water/cement ratio. A normal concrete mixer was used and the materials were poured inside it as follows: first the cement, the water and the aggregates, and then was slowly introduced the fibreglass; the blending was rather short so it wouldn't produce a breaking or/and an agglomerating of the fibres.

For the process of water elimination there were used forms with holes and water conduit ducts, used for the pressing of the paste as well.

The wrapping technology is realized by enfolding the long fibreglass or fibreglass fabric on the rotating form; the fabric is first soaked in a cement paste bath. By the use of this method there are obtained linear elements (cylindrical and prismatic) or bi-dimensional elements (plane and curve).

The throttling technology uses long fibres as well, which are first soaked in a cement paste bath. The mortar and the fibres are set in forms, in alternant layers. Using this method are obtained bi- or tri-dimensional elements with thin walls and linear elements with different profiles, as in the case of the pre-mixing technology with the climbing shuttering procedure.

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UTILIZAREA FIBRELOR DE STICLĂ LA ELEMENTELE DIN BETON ARMAT

(Rezumat)

Principalele elemente constitutive ale betoanelor armate cu fibre de sticlă sunt fibrele de sticlă, liantul, nisipul şi apa. Pentru modificarea anumitor proprietăţi se mai pot folosi diverşi aditivi sau filere. Fibrele de sticlă se folosesc sub formă de fascicule şi cordoane cu lungimi de 12...50 mm; tăierea se poate realiza cu dispozitive variate, proiectate, construite şi folosite de diverse firme.

Lianţii folosiţi pentru fabricarea betoanelor armate cu fibre de sticlă sunt: *lianţi hidraulici* – pe bază de ciment Portland, ca cimentul Portland obişnuit, cimentul Portland cu adaosuri, cimentul cu întărire rapidă (la noi în ţară RIM); cimenturi albe şi colorate; cimentul aluminos; *lianţi nehidraulici* – ipsosul, cimentul magnezian, argila.