## REINFORCED CONCRETE CONSTRUCTION FOR TEXTILE MILLS.

The textile manufacturer who intends to build a new mill or make an addition to his mill, had better look into the merits of a reinforced concrete building, since there are several points which are in favor of the concrete building.

WHAT IS REINFORCED CONCRETE?

Reinforced concrete is a technical name for a method of fireproof construction in which the only materials used are cement, sand, broken stone and steel. Concrete is a combination in proper proportions of the first three, forming a hard and permanent substance similar in texture and hardness to granite. Any good building material must resist the pressure and pull of weights and stresses. The concrete resists the pressure and the steel the pull. The proper combination of these two gives any structure capacity to carry weights. Steel is added to the concrete to produce elasticity, which is essential to any good building material. This addition of steel is called reinforcement—*hence the name reinforced concrete.*

THE COST OF CONSTRUCTION of a concrete reinforced building is less than that of a building of brick or stone. This is becoming more noticeable daily, because the price of wood, brick, and building stones is becoming higher and higher, while the price of cement, which is the costliest constituent of concrete, is growing less and less due to the enormous demand for it. Moreover, in concrete construction very few skilled laborers are required, most of the work can be done by unskilled laborers, under proper supervision, so that there will be a great saving in wages. Another source of economy in reinforced concrete construction lies in the comparative lightness of structures erected according to this method, thus effecting a considerable saving in very many instances in foundation work. Thinness of the walls, floors, etc., more than compensates for the extra cost of the concrete required in the mixing and depositing of concrete and in the placing of the reinforcement. A seven or eight-inch reinforced concrete wall will replace one of brick twenty-five inches thick. This difference in the thickness of the walls gives therefore an increased floor space which is a very desirable item in connection with the construction of textile plants.

Concrete buildings can be erected much quicker than buildings of any other material. Walls can be moulded a great deal quicker than they can be built of stones or brick; and floors and roofs can be moulded at the same time as their supporting beams.

It can be readily seen of what importance this saving of time is to the mill owner; he can install machinery and start operations that much sooner.

Although the concrete buildings can be erected faster than stone or brick buildings, they are stronger than stone or brick buildings. *Concrete is indestructible,* it resists the action of water, moisture and steam, and resists the action of salt water better than any other material used for building, an item which will be of special interest to our mills located near the coast. Some of the most ancient structures in the world had been built of this material and are to-day apparently in as sound a condition as they were when they were first completed; in fact they are sounder, because concrete becomes harder and more resistant as it grows older. This may seem absurd but it has been proven by experience. Tunnels and roads built of concrete by the Romans, are still in a good condition.

FIREPROOF. Another thing to be considered is that reinforced concrete buildings are fireproof. A mill with floors, walls and roof of concrete has practically nothing which can take fire, and if there are any fires in the neighborhood, the heat from these fires does not affect the concrete walls, they do not crack or bend. If any material in a concrete building should take fire, there are no wooden floors to help feed the fire and it can be kept under control.

Illustrations of the fire resisting qualities of reinforced concrete are numerous. The Pacific Coast Borax Company had a building of reinforced concrete; one day the materials which were stored in it took fire and a large conflagration resulted. The heat resulting from this conflagration was so great that brass and iron fittings were melted to a shapeless mass. The building itself was unhurt, except where an 18 ton tank had fallen through the roof and struck the concrete floor. The floor was cracked by this mass falling on it, but the injury was repaired.

In the fire which destroyed a large portion of the business section of Baltimore, a concrete building which was surrounded by buildings which were not fireproof, resisted the tremendous heat resulting from these buildings when they burned, a slight scaling of the exterior surface and a few cracks which were easily repaired was the only injury resulting from this fire.

The insurance writers recognize the fire resisting qualities of reinforced concrete and give lower rates for insurance.

TANKS. A fact that will be of interest to Dyers, Bleachers, Finishers, etc., is that tanks, reservoirs, and tubs can be constructed of reinforced concrete and that they have been found superior to those made of wood, which rots, or iron which rusts. The concrete tank withstands the action of acid and alkalis better than iron and wood. Wooden tanks when not in use become dry and warp so that when a solution is put into the tanks they leak. On the other hand, concrete tanks can remain empty a long time and will not leak when they are again used.

HEAT. Concrete is a very poor conductor of heat. For this reason a concrete structure is cooler in summer and warmer in winter than other structures, which absorb and conduct the heat and cold. This is especially true on the top floor of the mill or any other building; every one has noticed in commonly constructed mills, how hot the top floor is in summer, and how cold in winter; whereas concrete roofs keep out the heat and the cold.

STRENGTH. Another very important point in favor of a concrete mill structure, etc., is its monolithic nature and rigidity. A concrete building is a unit; it may be considered as a big stone, out of which has been cut cavities for rooms; every particle in it is firmly connected with other particles, therefore the concrete building resists vibrations to a great extent. This resistance to vibration is noticeable in buildings containing machinery, *i. e.,* our textile mills, and where the absence of vibration is not only beneficial to the mill structure itself, but to the machinery. The latter runs more smoothly, and not being subject to external vibration enjoys a longer life. The machinery does not break down so often, nor does it require so many repairs. Repairs to machinery is a large item to the expense account of mill owners, and anything that reduces this expense is desired.

Swampy Ground. For buildings which are to be erected on bad and swampy ground, reinforced concrete can be used to great advantage. A reinforced platform under the mill building, supported if necessary on reinforced concrete piles, makes a good foundation; one that is able to resist the stress of unequal settlement. Moreover, since a concrete building is lighter than a brick or stone building there will not be so great a tendency for settling or sinking as there would be in a heavier building.

Sanitary. Concrete buildings are more sanitary than the ordinary brick or stone buildings. The latter have wooden floors which decay and warp, forming cracks where dust can settle and where bugs such as roaches, ants, etc., can find lodgment. In a concrete building, where the floors are of concrete, there are no places where the dust can settle; the floors can be easily cleaned and there are no cracks where bugs can penetrate. Rats and mice find it almost impossible to bore through the concrete floors, so that they are kept away and the premises kept cleaner.

In the recent earthquake and fire in San Francisco, buildings made of concrete resisted the action of the earthquake to a greater degree than buildings built of any other material. In fact, they were scarcely injured by the earthquake, and the fire which followed did very little damage to them.

**The mixing of concrete is interesting,** the proportion of material being, one part cement, two parts sand, and three parts of crushed stone. The proportions are often changed, depending on the character of building to be constructed and upon the judgment of the engineer in charge. One method is to mix the sand and cement while still dry. Then to this mixture add the crushed stone which is crushed into pieces the size of a walnut. The crushed stone should be clean and should be of some hard stone, *e. g.,* trap rock. Water is added at the same time that the stone is. The amount of water added is not measured, the man in charge of the mixing knows by the appearance of the mixture when sufficient water has been added.

Great care must be taken in the selection of materials. The cement must be a high grade Portland cement. The sand must be clean sand, (if necessary washed sand) it may be coarse or it may be fine, but a mixture of coarse sand and fine sand has proven most satisfactory, because the fine sand fills in small holes which coarse sand would not. Clay and loam are injurious in sand because they do not enter into combination as well as the sand. The stone also must be clean and should not contain much dust.

A mechanical mixer is now frequently used. This does the work much quicker than a laborer and does it equally as good. The mixer consists of an iron tank in which there is a stirring device, which is run by steam or electricity. The cement, sand and stone are emptied into a hopper in the right proportions, the sand and cement are emptied directly from their sacks without previous mixing, and the crushed stone added. Water is continually fed into the mixer by means of a hose and the materials are thoroughly mixed. An opening at the lower end, which can be opened or closed, permits the mixture to be taken out as required. This is a continuous mixer.

Some mechanical mixers known as batch mixers receive one charge at a time, mix it thoroughly and then empty the whole charge. These batch mixers mix the concrete better than the continuous mixer previously explained, because the whole charge is put in at one time and thoroughly mixed. The continuous mixture has to be fed uniformly or else the concrete will not be mixed thoroughly.

The concrete is now ready for use. Concrete is rarely used alone, it is generally used with steel, the steel adds a property which the plain concrete does not possess; this property is elasticity. Plain concrete will stand great pressure or weight, but it cannot resist so well a tension or pulling strain. Since steel can resist the pulling strain, the addition of the steel to the concrete adds this property to it. There are many methods of reinforcing concrete. A description of these methods would be of a too technical character for any but a civil engineer. It is sufficient to say that steel in the form of twisted bars, corrugated bars, or in the form of a wire is usually used. This steel is in general used as a skeleton, about which the concrete is poured. The concrete protects the steel from water and air, and the steel therefore lasts as long as the concrete. The steel adds to the tensile or pulling strength, and is therefore useful for floors which must sustain great weights; the steel also strengthens the walls and supports, but is not so necessary in foundations of buildings.

Illustrations Fig. 1 to Fig. 9 will show how steel may be used for reinforcing concrete. These illustrations show how means are provided for tying the metallic frame members together, so that they will be held in proper relation to each other until the concrete has been placed about them. These illustrations show how, according to a recent patent, the steel is kept in place before being surrounded and imbedded with concrete.

Fig. 1 shows a reinforced girder. Fig. 2 is a sectional view of this girder taken along the line $A - A$ of Fig. 1. Fig. 3 is a sectional view of the girder taken along the line $B - B$ of Fig. 1. Fig. 4 illustrates the method of tying the metallic frame members together in the case of a column, the limits of the surrounding concrete being shown by dotted lines. Fig. 5 is a cross sectional view of Fig. 4, executed on a somewhat smaller scale, the cutting plane being horizontal and passing just above the uppermost clamps. Fig. 6 is an edge view of a straight clamp. Fig. 7 is a similar view of a diagonal clamp. Fig. 8 is a plan view of the clamps shown in Figs. 6 and 7; and Fig. 9 shows a modified form of a clamp used where the frame-members are of circular cross-section.

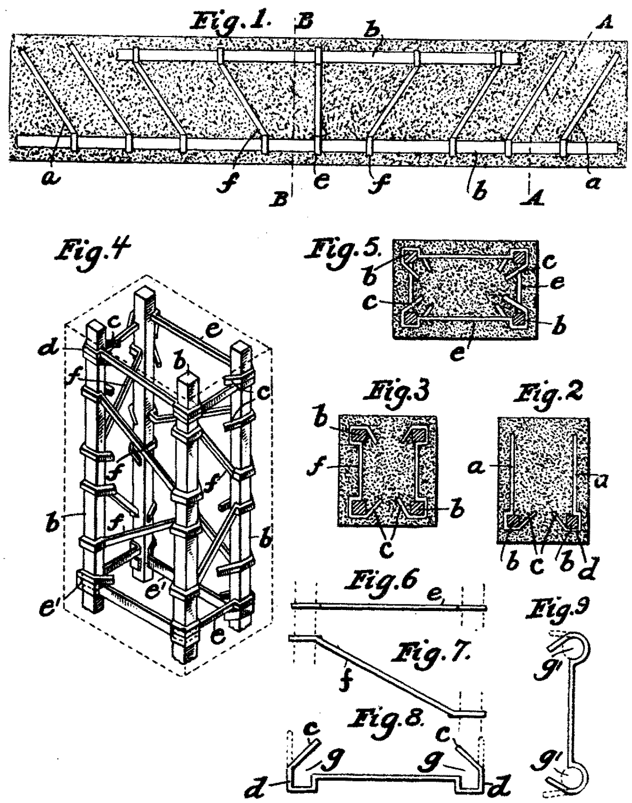

Fig. 1 shows a girder in which the anchor-member *a* is formed at one end, so as to fit snugly around the main reinforcing bar *b*, on three sides; and this end terminates in a finger *c* which lies in prolongation of the side *d* when the anchor-bar is placed upon the reinforcing bar *b* and before the concrete is placed.

Before the concrete is placed around the reinforcing bars *b*, the finger *c* is bent inwardly and thereby it serves to anchor the bar *a* and to secure it in position on the reinforcing bar *b*. The free part of the bar *a* extends diagonally outwardly from the reinforcing bar *b* and serves to give stiffness to the structure. Figs. 2 and 3 show the prolongation of the side *d* and the finger *c* which cannot be seen in Fig. 1.

In order to secure a pair of the reinforcing bars *b* together, the clamp-bars *e*, *f* are provided. These clamp-bars are formed at each end with recesses *g* in all respects similar to the recess formed upon one end of the anchor-bar *a*. The walls of the recess *g* closely engage the frame-member or reinforcing bar *b* upon three sides and both ends of the clamp-bars *e*, *f* terminate in a finger *c* identical with the finger *c* upon one end of the anchor-bar *a* and used in a like manner for a like purpose. The central clamp-bar *e* is straight, while the clamp-bars *f* on each side of it have their central portion inclined to the plane of their ends, so that they form practically diagonal braces.

In Fig. 4 the application of the system of bracing to the frame-members or reinforcing bars *b* of a column is illustrated. At the top and bottom of the column clamp-bars *e* are placed so as to prevent the frame-member *b* from spreading apart or from becoming otherwise displaced. Between the upper and lower sets of clamp-bars *e*, diagonal clamp-bars or braces *f* are placed which connect frame-members upon the same side of the column. Thus, the frame-members *b* are held rigidly in place and great stiffness and structural strength is given to the column with the addition of very little weight and at a very low cost. It will be understood that all the clamp-bars and braces are provided with fingers *c* which are bent inwardly before the concrete is placed and serve to anchor the clamp-bars and braces in place.

In case the length of the frame is to be increased by placing one reinforcing bar in prolongation of another, broad clamp-bars *e'* are used which are of sufficient width to cover the abutting ends of both bars to some distance on both sides of the joint. (See the lower part of Fig. 4.)

In the modified form of a clamp as shown in Fig. 9, the recess *g'* is shaped to receive a reinforcing-bar of circular cross-section; and in any case, the recess will be of a form complementary to that of the cross-section of the bar which is to fit into it.

The consistency and wetness of the concrete mixture is a disputed point. There are three mixtures which are distinctly recognized; these are the *dry* mixture, the *medium* or *quaking* mixture, and the *wet* or *mush* mixture. It is now being recognized that each kind of mixture is particularly suited for some special kind of work.

THE DRY MIXTURE (just enough water is added to it to give it the consistency of damp earth) is used for mass foundations which must stand great compressing a short time after being placed; because, as can be readily seen, a mixture of this sort will dry quicker and become hard quicker than a mixture containing more water. Its final state of hardness is not any harder than that which the other mixtures furnish.

THE MEDIUM or quaking jelly like mixture is one to which just enough water is added to give the mixture a tenacious, jelly like character, it sticks to the shovel; this is used for foundations, arches, and heavy walls.

THE WET or mushy mixture is thinner and runs easily and quickly off the shovel; this mixture is used for thin building walls, for floors and for tanks.

NOTES. In the erecting of the mill building, the mixed concrete is poured into molds or frames. These molds or frames are made of planks one or two inches thick and of various widths. White pine is the best lumber to use, but hemlock, fir and spruce are also used. Green wood is better than dry wood, because the dry wood absorbs the water in the concrete. The

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