3. Steel Frame Buildings.—This class of construction is used for rolling mills, machine shops, foundries, etc., which are usually classified under the head of mill buildings. Its distinctive feature is the steel skeleton which forms a frame to support the roof and side covering. This covering is usually corrugated iron, galvanized and sometimes painted also. When so constructed, the building is entirely metal, even the window sash may be made of steel. The result is that it can stand an immense amount of rough usage and unless filled with inflammable material, is not easily injured by fire, nor is it effected by the elements provided it is regularly painted and properly cared for.

But in a building of this class its function as a protection from the weather is really secondary, its main duty being to sustain cranes, hoists, and other machinery. In fact the structure is a huge machine itself. In its design the same engineering principles are applied which are used in the building of steel bridges. Every possible stress is estimated and provided for. Often the analysis of these stresses is made extremely complicated by special combinations of traveling cranes, bins, machinery and wind pressures, but all must be taken care of if the building is to be rigid and safe.

Each of the above three types of construction has its own special advantages, and they are often combined in various ways to obtain a desired result. The slow-burning construction has the advantage of being cheap in first cost. Until recently it had a further advantage of time in rapid erection, but it is now so difficult to obtain first-class lumber and the cost is such that these advantages are lost. The commercial size and length of timbers obtainable also limits the span of beams and the spacing of the columns, as explained above. However, for factory buildings, such as woollen and cotton mills, etc., where the machinery is small and light, this feature is not necessarily objectionable. But the one which weighs heaviest against it is its inflammability. That means, for one thing, high insurance rates and the ever present danger of fire.

The first natural variation, made in slow burning construction, is the substitution of steel for beams and columns. This permits longer spans for the beams and heavier loads on both beams and columns. Steel columns are often put in the outside walls as well. The steel work is then self-supporting and may be erected complete independently of other trades. As these columns relieve the walls of all beam loads, and also reinforce it, the walls may be made much lighter than would otherwise be permissible. As a fire risk, however, this combination is considered inferior to the slow burning construction. Steel becomes soft at a red heat and is entirely unable to resist stresses. If, when thus heated, a stream of water is directed on it, it warps and twists. While an ordinary fire will not actually destroy the metal, the physical state of the material may be so altered as to be entirely unreliable. Consequently its salvage value is only what it will bring as "scrap."

In buildings of three or four stories, round cast iron columns are sometimes substituted for the rolled steel. If neatly cast, they present a better appearance than the built-up steel column, but unless designed by one accustomed to working with cast iron, and unless they are most rigidly inspected, there is always a very great uncertainty as to their strength. Apart from this unsatisfactory feature, cast iron has the advantage over steel in being better able to resist heat. They will usually cost more than the steel column.

If, in buildings where steel is used, it is protected by about two inches of concrete, practically all the risk of damage from fire is eliminated. This is rarely, if ever, done if the floors are of wood, for if the fireproofing is carried to this extent, it only means one step more to make the building entirely fireproof. Wood floors, however, have this advantage, in addition to being cheaper. It is much easier to cut openings or bore holes in them than it is in concrete, and that is an item worth considering where there is likely to be much of this work to do.

As stated above, buildings which are to be fireproof must be constructed entirely of reinforced concrete, or steel covered with concrete or terra-cotta. Buildings of this type have come through conflagrations and earthquakes with credit. The one thing to remember in using reinforced concrete is that there must be no slighting of the work whatever. To get a good job, it is sometimes a continual fight against ignorance and carelessness, and sometimes dishonesty. A mistake once made is very hard to remedy. A defect may easily escape notice until a catastrophe occurs. Many accidents have already been recorded and there have probably been many more that have never reached the ears of the public. There are large new buildings which stand finished, but vacant, and condemned.

That this blot against reinforced concrete is not fair to this construction, is proved by the fact that many engineers, especially European engineers, get quite satisfactory results although they use much higher unit stresses than the average. The secret is that they take more time for the work, and give it more rigid supervision.

By using a steel frame work for a building, much of the uncertainty as to its safety may be done away with. There is also a saving of head and floor space, as the steel beams and columns are smaller than those of reinforced concrete. In a building of many stories a few inches to each story adds up to quite an item. The columns in the lower stories become so large that, as one writer has put it, the building resembles the Egyptian pyramids—most of the room is on the outside. Nor are engineers agreed as to how concrete sets when poured wet in large masses.

There are other objections to the use of reinforced concrete for certain classes of manufacturer's buildings. Where it is necessary to make frequent changes, alterations and repairs and, in fact, in any structure that is not intended to be permanent for many years, it becomes very costly. When it has outlived its usefulness it is expensive to remove and the materials have little or no value.

Referring to steel frame mill buildings, structural steel has other useful properties in addition to those referred to above. Such a building is not limited to any size, shape or form within reason. Any loads can be taken care of with certainty. The erection of the frame usually goes ahead very rapidly, forming a scaffold for other work. Steel must, however, be frequently painted if exposed to moisture or corrosive gases to prevent rust and corrosion.

REINFORCED CONCRETE.

Mr. G. C. Workman, M.S.E., M.C.I., read an interesting paper recently on "Some Recent Works in Reinforced Concrete," before the Concrete Institute of England.

The object of the paper was to describe a few of the numerous works recently executed in reinforced concrete, and to bring out some of the more interesting features of each particular case, and to show how various difficulties had been overcome. The author said that, owing to modern requirements, there was a growing tendency for the various barnches of engineering to become specialized in order to obain by a continual study of each subject, the maximum amount of economy and efficiency.

It was for that reason that a certain number of engineers had become specialists in the designing of reinforced concrete, each one adopting the particular method of reinforcement which he thought best suited for the purpose.