resting upon them shall have riveted or bolted connexions to unite them with the pillar. If cast-iron pillars are used, each successive pillar shall be bolted to the one below it by at least four bolts not ess than three-fourths of an inch in diameter, and the beams and girders shall be bolted to the pillars. At each line of floor- or roof-beams, lateral connexion between the ends of the beams and girders shall be made by passing wrought-iron or steel straps across or through the cast-iron column, in such a manner as to rigidly connect the beams and girders with each other on the direction of their length. These straps shall be made of wrought-iron or steel, and shall be riveted or bolted to the flanges or to the webs of the. beams or girders.

“ If buildings are made fire-proof entirely, and have skeleton construction so designed that their enclosing walls do not carry the weight of the floors or roof, then their walls shall be not less than twelve inches in thickness; and provided, also, that such walls shall be thoroughly anchored to the iron skeleton, and pro­vided, also, that, whether the weight of such walls rests upon beams or pillars, such beams or pillars must be made strong enough in each storey to carry the weight of wall resting upon them without reliance upon the walls below them. All partitions must be of incombustible material.”

With the introduction of cheap structural steel, steel cage construction came rapidly into use. The dimensions of the exterior piers ceased to control the height of the building, which was limited alone by the possibility of securing adequate foundations, and by a considera­tion of the amount of floor space which could be devoted without too great loss to a system of passenger lifts of sufficient capacity to afford speedy access to all parts of the building. The advantages that led to the very rapid intro­duction of this system were not only the power of greatly reducing the size of the piers, but the enormous facility afforded for quick construction, the small amount of materials relatively used and the proportionately small load upon the foundations, and the fact that as the walls are supported at each storey directly from the cage, the masonry can be begun at any storey indepen­dently of the masonry below it. It is a disadvantage of the system that defects of proportion, material, or workmanship, which would be of less moment in an old-fashioned construction, may become an element of danger in building with the steel cage, while the possibility of securing a permanent protection of all parts of the cage from corrosion is a most serious consideration. The safety of the structure depends upon the preservation of the absolute integrity of the cage. It must not only be strong enough to sustain all possible vertical loads, but it must be sufficiently rigid to resist without deformation or weakening all lateral disturbing forces, the principal of which are the pres­sure of wind, the possible sway of moving crowds or moving machinery, and the vibration of the earth from the passage of loaded vans and trolleys, and slight earthquakes which at times visit almost all localities. In buildings wide in proportion to their height it is the ordinary practice to make the floors suf­ficiently rigid to transfer the lateral strains to the walls, and to brace the wall framings to resist them. In buildings of small width in proportion to their height this method of securing rigidity is generally found to be inadequate, and the frame is also braced at right angles to the outer walls to take up the strains directly. In each case all strains are carefully computed. The bracing is accomplished by the introduction at the angles of the columns and girders or beams of gusset plates or knee braces, or by diagonal straps or rods properly attached by rivet or pin connexions. All portions of the frame are united by hot rivets of mild steel or wrought iron, care being taken that the sum of the sectional areas of rivets affords in each case a sufficient amount of metal for the safe transfer of the stresses. The greatest care should be taken to see that all rivet holes are accurately punched, and if necessary that they are rhymed so that each rivet will have its full value.

For the proper and successful erection of the frame much depends upon an accurate alinement of the column bases. These should be properly tested as to position and level. The bases are either grouted with cement, or bolted to the founda­tions, but where cast column bases, rest on masonry- piers or footings any considerable grouting is not advisable. The only grouting that should be permitted in tall buildings would be in levelling up the tops of the concrete footings to receive the masonry courses, or in a very thin layer between the column pedestal and the masonry bed. The cap stones should always be brought to the most accurate bed possible, with grouting used as a thin cement and not as a backer. Accurate redressing of the cap stones after setting is much to be preferred.

All riveting and punching of the steel members is done at the shop, where also they receive the usual coat of oil or paint. This leaves the assembling and field riveting to be done on the ground, together with the adjustment of the lateral or wind-bracing, the placing of tie rods and the field painting.

After erection the steelwork should receive one or two coats of paint; two coats arc to be recommended, in which case they should be of different colours. Red lead is best for the priming coat and oxide paint for the finishing coat. In German specifications it is required that the steelwork should first receive a coat of boiled linseed oil, in order that the red lead coating should be more coherent with the steel.

Steelwork that has to come in contact with brickwork or concrete should not be painted, but should receive a wash of cement as the brickwork or concrete-work proceeds. The steelwork which is exposed to the weather should be painted about every three years, but when it is under cover an interval of five years may elapse.

To secure painting of permanent value a clean scaleless and rustless surface is first necessary. Steel plates and shapes, when delivered from the rolls which form them to the cooling beds, are largely covered with scales, which, adhering only partially to the surface, offer the intervening cracks or joints as vulnerable points for rust. After being rolled, structural steel is stored or handled out of doors for a varying period both at the mill and then again at the shop before the building is started. This period of open-air exposure allows the process of rust to start under the scales. If the rust so covered up has not begun to pit the iron the chances are that it will do no harm; but, if it is already well developed and of some thickness, it will have enough oxidizing agents in its pores to develop more oxide, and to swell up and crack the paint. The first requirement, therefore, for efficient painting is the careful removal of all mill-scale, rust, grease, or foreign substance, before even the priming coat is applied. It is agreed that the first step in the preservation of metal-work against deterioration or corrosion is the obtaining of absolute cleanness of metal before the application of paint or oil.

The following are the requirements of the New York building law in regard to the protection of iron or steelwork against corrosion, &c.:—

“ All structural metal-work shall be cleaned of all scale, dirt and rust, and be thoroughly coated with one coat of paint. Cast-iron columns shall not be painted until after inspection by the Depart­ment of Buildings. Where surfaces in riveted work come in con­tact they shall be painted before assembling. After erection all work shall be painted with at least one additional coat. All iron or steel used under water shall be enclosed with concrete.”

The Chicago ordinance makes no mention of paint or coating to prevent rust in metal framework. The London Building Acts do not set out any special requirements, but suggestions have been made at the Royal Institution of British Architects for the regulation of skeleton buildings and they are drawn up upon a more scientific basis than the bulk of the existing acts.

In transferring the loads from the column bases to the bottom of the footings the greatest care must be taken in all systems of construction that the stresses throughout at no point exceed the safe limits of stress for the various materials used. Steel is generally used for columns in preference to cast iron, because it affords greater facility for securing satisfactory connexions, because its defects of quality or work­manship are more surely detected by careful test and inspection, and because, on account of its superior elasticity and ductility, its fibre is less liable to fracture from slight deformations. It is used in preference to wrought iron on account of its lesser cost.