vertical fissures caused by pressure. The stone was the compact limestone of the neighborhood ; the upper stones of the quarry were laid in the base of the towers, about 20 ft. high on the Canadian side and 10 ft. higher on American side. The stone from the lower quarry beds were laid in the upper portion of the structures which was found most perishable. There were a pair of towers at each end between which the railway and the highway road underneath it passed. The superstructure of the towers was in the form of the frustrum of a pyramid 15 ft. square at the base and 8 ft. square at the top, where the iron saddle with the roller bed is bedded upon the masonry. When the masonry towers were taken down many of the stones were found to be only half bedded, which gave rise to complex stresses in the towers, and was one cause of failure.

Having briefly reviewed the most prominent disparities which occur in practical instances to more or less extent, it evidently becomes a question of supreme importance in each case to determine the value of these factors as far as they apply. The suitable factor of safety cannot be determined intelligently without such investigation, but when they can be satisfactorily ascertained a more economical factor of safety can be used to cover what still remains doubtful. Sir Benjamin Baker in 1884 stated that "the factor of safety of 4 will be obtained as regards all shearing, tensile, and compressive stresses to which the masonry may be conceived to be liable under any reasonable hypothesis which can be framed." Doubtless the circumstances of the Niagara masonry suspension towers are quite outside any reasonable hypothesis conceived at the time by Sir Benjamin Baker, because (1) the climatic extremes were abnormal, (2) the suspension bending stress due to contraction and expansion of over 2 in. horizontal in winter, and (3) the railway line load stresses on a suspension structure induce bending moments. To these should be added the rigidity of massive country rock foundation, which intensified the stresses, and the height of the masonry was above average. However since the load was 36 tons per foot of cross-section and the compressive resistance of compact limestone is usually given at 500 tons per square foot, then $500/36 = 14$ nearly as the factor of safety taken by the builders of these masonry towers. On the other hand, Prof. Unwin recommends 20 as the factor of safety for dead loads and 30 for live. Stoney suggests 20 for arches for dead load. Prof. Rankine names 10 for dead loads under various conditions. It is not surprising that authorities should differ so widely in this important matter, for each had in view at the time a particular range of conditions which was intended to be covered by the factor of safety which they respectively recommended.

There is individuality with practitioners in all branches, each for a special reason adopting his own method in matters of detail. Some architects and engineers adopt bond blocks in brick piers, which are well loaded, with the view of equalising the stresses and rendering the pier more homogeneous. Other architects again will prefer to trust to the bond of the brickwork, as they consider that the bond stones throw all the load upon the shell of the face, because of the difficulty found in obtaining sound bedding of the block in its centre area upon the brickwork. It may here be noted that there would be the same objection to having a template and base block upon the top and bottom of the pier to receive its load. These latter blocks cannot well be dispensed with, and the bedding has to be relied upon for transferring and distributing the load stresses. Of course, it has been found in many instances that stone blocks of an area of, say, 5 ft. or 6 ft. superficial in the bed requires careful bedding to have it solid throughout its centre. In many cases grouting is resorted to for filling up not only bed-joints, but for bonding work together with cement. If the grout has sand in its composition, the sand and the cement having different specific gravities, the heavier (sand) will naturally be most in the lower levels, while the lighter cement will be in excess in the upper levels.

In abutments for arches and retaining walls there is always a varyingly large proportion of horizontal component in the thrusts. In the case of the abutment the amount of the horizontal component is increased as the arch is flattened. Abutments in some cases act also as retaining walls, having horizontal components acting in opposition to those of the arch. Such cases occur in ravines, cuttings, high river banks, and such like positions. The theories respecting the stresses in arches are various, according to the assumptions made by the investigators, each of whom believes that his method frees the problems from indeterminate results. Unfortunately some of these theories differ seriously from each other. There is a similar diversity of theories respecting the stresses in retaining walls. All rules for the solution of the problems for obtaining the direction and intensity of the masonry stresses encountered by retaining walls rely on certain foundamental principles and assumptions respecting the action of the earth at the back : (1) as to the nature of the surface of earth rupture ; (2) as to the concentrated point of application of the earth force ; (3) as to the direction which the earth pressure assumes. All earth or soil differs more or less from any generally assumed convenient classification, and they also differ in condition, and the condition varies according to season and the effects of the weather, recent and present.

ITALIAN BRICKWORK.

ITALIAN bricks are by no means of very fine quality save where moulded bricks are used, but the Italian architects, says the British Clayworker, differ from others in the extent to which they made use of stone intermixed with the brickwork of their buildings. The arrangement refers not only to the occasional introduction of stone voussoirs in the arches, but to the commonly recurring system of horizontal courses of stone alternating with courses of brick in the walling. Sometimes this is regularly carried all over a wall, sometimes only a course of stone is introduced here and there to mark some line or feature which appeared to require considerable emphasis. Sometimes again, as in the Romanesque apses of San Fermo Maggiore, Verona, a single course of brick is introduced between all the courses of stone, and the effect of this is delicate and good. The same church contains many examples of very ingenious mixture of stone and brick, and, on the whole, few examples are altogether more valuable. Sometimes we find, as in a wall in San Stefano, Bologna, the wall diapered regularly in brick. Here the diaper is made with thin red bricks arranged in diagonal lines all over its surface, the squares contained within them being all of yellow brick. This kind of work is never pleasant, save for the filling in of a spandrel, or some such place where no strength is required. It gives, of course, the impression of being a veil to the wall and not the wall itself.