the upper portion of the walls of a building when it is found necessary to reconstruct the foundations or to make large openings in the lower parts of the wall, as, for example, when putting a shop front in an existing building. This form of shoring consists of horizontal members of balk timber termed *needles* (very different from the needles used in raking and flying shoring), which are passed through holes in the wall to be supported, at a sufficient height to allow of the insertion of any arch or lintels that may be necessary above the opening it is proposed to cut (figs. 5 and 6). The needles are sup- ported at each end by an upright timber or *dead shore,* one on each side of the wall to each needle. These should not be allowed to rest upon any floor or vault but be carried down to a solid foundation and set upon and securely dogged to a timber sleeper running parallel to the walk If it is not practicable to take the inner dead shore through intervening floors down to the solid ground in one piece, and it is necessary for its base to be set upon the floor or upon sleepers placed on the floor, the strutting must be continued in a direct line below it until a firm foundation is obtained. Between the needle and the head of the dead shores folding wedges are in­serted to force the horizontal supporting balk firmly up to the underside of the masonry. Connexions between the dead shores and the needles and sleepers are made with wrought iron dogs. The spacing of the systems of dead shoring depends to a large extent upon the material with which the wall is constructed; for brickwork they should be placed at intervals not greater than 6 ft. With this form of shoring especially it is often found necessary to adopt other methods auxiliary to the main shoring. These take the form of raking or flying shores from the face of the building. Al1 the openings in the wall above should be well strutted between their reveals to prevent any alteration of shape taking place. Inside the building vertical shores or strutting must be carried up independently in a direct line between the floors with head and sole plates at floor level and ceiling. This strutting must start from a firm foundation at the bottom of the building and be tightly wedged up so as to relieve the wall of any weight from the floors and roof. To obviate settlement as much as possible, work done in underpinning should be built slowly with Portland cement mortar mixed in strong proportions. Before the shoring is removed at least a week should elapse to allow the work to set hard and firm. Then the needles should be carefully loosened and removed and the holes from which they were withdrawn made good. The remainder of the props can then be “ struck,” leaving the raking or flying shores until the last.

If possible this work should be spread over several days, an interval of a day or two being left between the removal of each portion of timbering to allow the work gradually to set on its new bearings.

Shoring should be the subject of careful calculations to ascertain the most suitable sizes of timbers and to determine the most appro­priate points of support. This is not always done, however, and much work of this character is carried out by rule of thumb methods. The usual result is that the timber used is of a much greater size than is really necessary, although as the material is not much injured and is available on removal for re-use this fact is not of great consequence. Such methods perhaps work very well for ordinary buildings, but in special cases they may very well lead to shoring being constructed in too fragile a manner, with serious results. Some rules which experience has shown to work satisfactorily for ordinary work are given below, together with the ap­proximate scantlings of the timber required.

*Rules and Sizes for Raking Shores.—* Walls 15 ft. to 30 ft. high should have 2 shores to each system; if 30 ft. to 40 ft. in height, 3 shores each system; if 40 ft. or more in height, 4 shores, with an additional shore for each 10 ft. in- crease. Shoring is rarely seen more than

5 shores high. The angle of the main shores is usually about 60°, and none of the timbers should exceed an angle of 75°. Some of the lower shores will slope much Jess than this, at angles between 40° and 60°. The systems should not be placed at a greater distance apart than 15 ft. It is often found convenient to place them at the piers between window openings. As regards the sizes of the timbers used for walls 15 ft. to 20 ft. high, the shores may be 4 in. or 5 in. square in section; for walls 20 ft. to 30 ft. high, 6 in. by 6 in., or 9 in. by 4½ in. ; for walls 30 ft. to 35 ft. high, 12 in. by

6 in., or 8 in. by 8 in.; for walls 40 ft. to 50 ft. high, 9 in. by 9 in.; for walls above this height 12 in. by 9 in.

*For Horizontal or Flying Shores.—*For spans not exceeding 15 ft. the principal strut may be 6 in. by 4 in., with raking struts 4 in. by 4 in.; for spans exceed- ing 15 ft. but not exceeding 35 ft. the size of the principal strut should be from 6 in. to 9 in. square, and the raking struts from 6 in. by 4 in. to 9 in. by 6 in.

Interesting examples of shoring on a large scale may frequently be seen applied to large buildings in the course of repair or restora­tion. The rebuilding of the foundations of the retro-choir and lady chapel of Winchester cathedral which was carried out in the autumn