COMPRESSION MACHINE FOR TESTING STRUCTURAL MATERIALS.

WITH the increasing recognition of the necessitv for laboratory tests of concrete has come a demand for a simple machine for testing the compressive strength of specimens as large as 8 and 10 in. in diameter. Engineers and builders are beginning to appreciate the fact that a great deal of money can be saved on a large concrete job, amounting often to thousands of dollars, by proper selection and proportioning of the aggregates. To compare the qualities and proportioning of different materials, it is necessary to make fairly large concrete specimens with the cement and aggregate to be used on the work. Advance tests are also essential from the standpoint of safety, and to determine the allowable working compressive strength of the concrete in a reinforced-concrete structure.

In addition to these tests of specimens made in the laboratory, it is now required on important construction that blocks of concrete shall be made up in the field at stated intervals, and tested for compressive strength at ages of, say, 7, 14 and 28 days.

Compression machines of from 100 to 150 tons capacity for testing concrete specimens would be in much greater demand were it not for their high cost and their bulkiness. There are two types of compression machines on the market: Screw machines and hydraulic machines. For very large work the screw machines are preferred to the hydraulic machines; but for small work, the former have the disadvantages of high cost, heavy weight, large floor area required, and mechanical power necessary to operate.

The hydraulic machines now on the market lack some of the objectionable features of the screw type, being less in cost and in weight, requiring less floor area, and being generally operated by hand. However, they are still out of the reach of the smaller laboratories and of construction jobs where concrete specimens of 6 or 8 in. in diameter are made up for testing. The small hydraulic machines on the market at the present time within the reach of laboratories and construction jobs from the standpoint of cost and size, are not of sufficient capacity to test specimens of mortar or concrete larger than 3 in. or less in diameter. To obtain a good average sample of concrete, specimens should be cast at least 6 in. and preferably 8 in. in diameter. A machine to test specimens 8 in. in diameter must have a capacity of at least 100 tons. A capacity of 125 to 150 tons is still more preferable as affording a slight excess capacity and also providing for cases where it is desirable to test an old piece of concrete such as is sometimes cut from a wall. Such a piece, even after sawing the faces true in a power saw, is apt to be irregular in shape and may run a trifle over 8 in. in one dimension.

With a view to obtaining, particularly for tests of mortar and concrete, a reliable, accurate, and efficient machine of a capacity up to 125 tons, at a low cost, and requiring comparatively small floor space, a design was developed by W. H. Weston, under the supervision of Mr. W. O. Lichtner, consulting engineer, Newton Highlands, Mass., and described by the latter at the recent convention of the American Society for Testing Materials. His description is as follows:

This machine consists of an ordinary hydraulic jack like those used in ship-yard work, set in a frame consisting of a heavy base and top. The top of the frame is provided with a head block having a ball-and-socket joint with about ½-in. play in the joint, so as to adjust itself to the specimen and give it a square bearing.

To cover the range required by small specimens of mortar and large blocks of concrete, two gauges are necessary. These gauges are calibrated to read the total pressure on the ram. The small gauge registers up to 20,000 lb. by 100-lb. intervals, and the large gauge registers up to 250,000 by 1,000-lb. intervals, with possibility of interpolation for finer readings. Specimens of small sectional area will break under a comparatively small load on the ram, so it was desirable to be able to take readings by 100-lb. intervals when reading on the small gauge. When the pressure on the ram exceeds 20,000 lb. the stop-cock on the small gauge is turned off, which prevents any further pressure coming on this gauge. This arrangement has been found to work very satisfactorily. Both gauges are equipped with a "maximum hand" which consists of a wire held on the main stem of the gauge hand by a spring in the form of a bent wire. This leaves the wire loose enough to be pushed around the dial of the gauge, but not so loose as to be jarred out of position when the specimen breaks. The top end of the wire is bent outward so as to be caught by the gauge hand as it moves around the dial when the pressure is applied. When the pressure is released, the gauge hand returns to zero and leaves the maximum hand to indicate the pressure which was reached when the specimen broke. The gauges have been carefully calibrated and register accurately at all points.

In order to protect the large gauge from the sudden release of pressure occurring when the specimen breaks, it was found necessary to design a check valve to be inserted in the pressure line to the gauge. This check valve consists of a small valve seated by a spring. When the pressure is applied, it forces the valve against the spring, allowing the water to pass into the gauge. When a sudden release in pressure takes place, the spring seats the valve and the water in the gauge gradually runs back to the pump by means of a very minute by-pass, which is in reality only a small scratch on the seat of the valve.

The jack is equipped with a single-stroke compound pump. The large plunger is used in raising the ram to a height sufficient to tighten the specimen in the machine, and then this plunger is thrown out of service, which allows the small plunger to operate. The large plunger raises the ram about 0.08 in. per stroke, while the small plunger raises the ram about 0.02 in. per stroke. The load should be applied to the test specimen uniformly. This cannot be accomplished with quite the same uniformity in a hydraulic machine that can be obtained in a screw machine on account of the upward stroke of the pump handle. It has been found, however, that with care the pump can be so operated as to apply the load very evenly and without a jerk, and that by making a quick return stroke of the handle the pressure may be considered as being increased continuously. In applying the load, the ram should be raised at the rate of 0.026 ft. per minute, which can be done by operating the pump handle so as to make a stroke and return in 3½ seconds. A clock arrangement is being devised to strike every 3½ seconds, so that the man operating the machine can accurately regulate the pumping. When the load on the ram reaches the vicinity of 125,000 lb. or over, a pipe extension about 3 ft. long is put on the end of the 3-ft. pump handle. This gives the operator the necessary leverage to operate the pump without the assistance of another man.

A guard should be placed around the working parts of the machine to protect them and also the operator of