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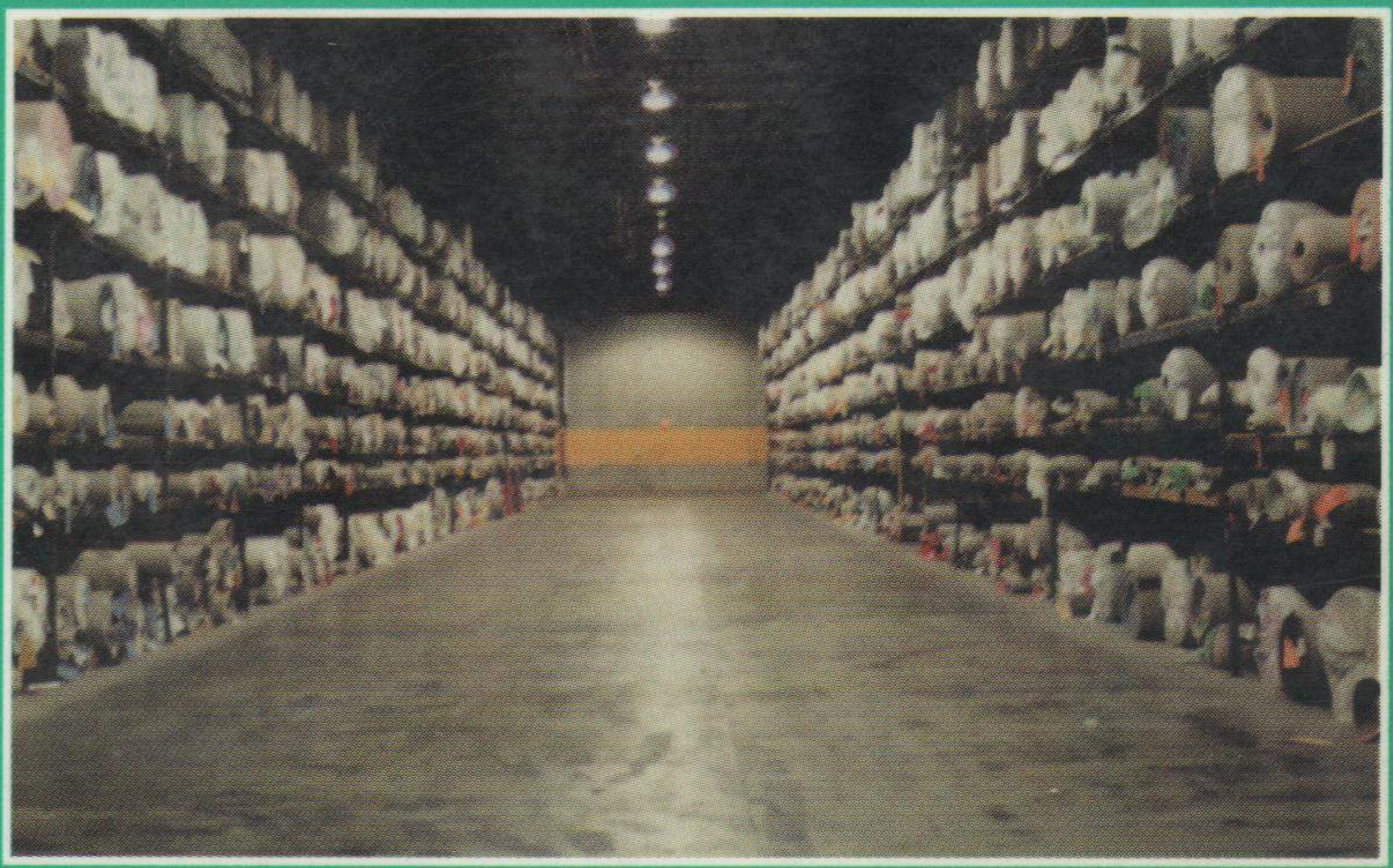
Concrete Floors on Ground



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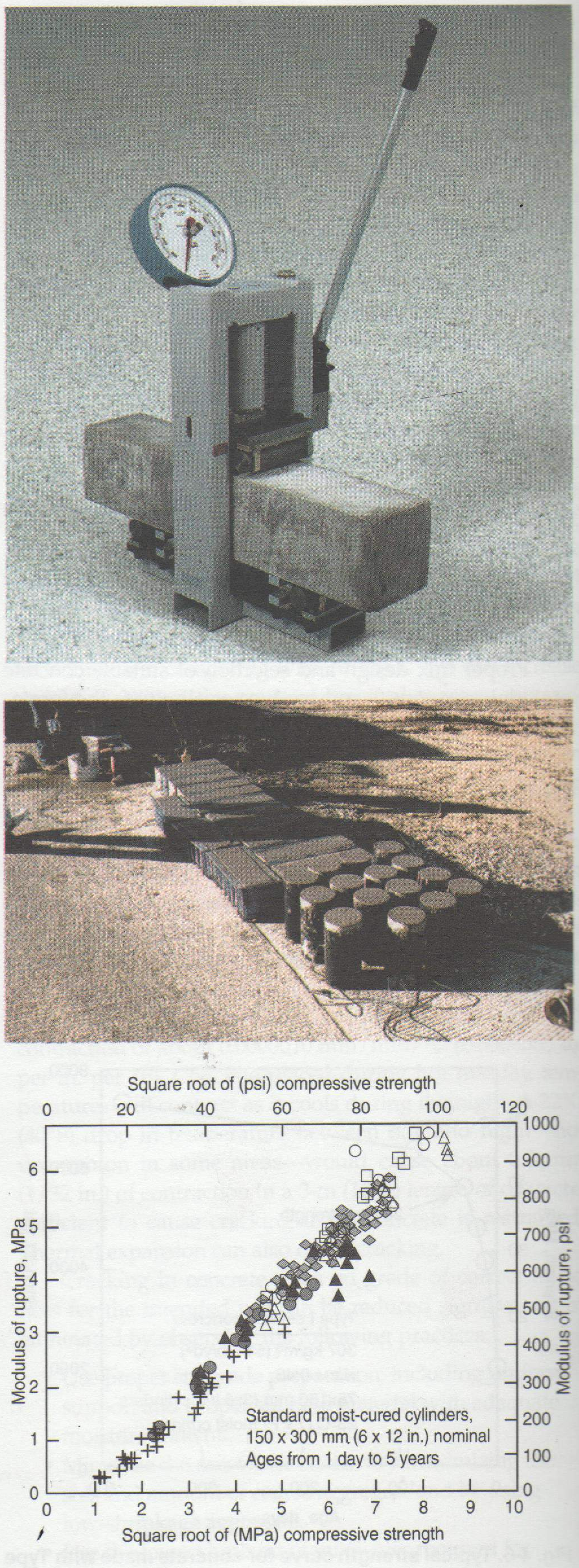

Fig. 4-8. (top) Third-point loading tests measure the flexural strength of concrete beam specimens in the lab or in the field with a portable flexural strength tester (shown here). Results from compressive strength tests of cylinders are correlated with flexural strength, useful in the quality control of concrete for floors. (middle) Companion beam and cylinder samples can be made and tested to deter-mine the relationship between flexural and compressive strengths. (bottom) Long-term data show that compressive strength is proportional to the square root of flexural strength (measured by third-point loading) over a wide range of strength levels (Wood 1992). (69684, 69653)

fail do so as a result of failure in flexure. Consequently, *the flexural stress and the flexural strength (modulus of rupture) of the concrete are used in floor design to determine slab thickness.*

Flexural strength is determined by modulus of rupture (MOR or MR) tests in accordance with ASTM C 78, *Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)* (see Fig. 4-8). Usually the 28-day strength is selected as the design strength for floors. This is generally conservative since the concrete continues to gain strength after 28 days. It may not be conservative when early-age construction loading occurs.

There are some difficulties associated with flexural strength testing. The test specimens are large, so they are somewhat difficult to handle. The measurement of flexural strength is quite sensitive to variations in test specimens and procedures, more so than compressive strength testing. Compressive strength cylinders (see Fig. 4-8) are easier to make and move, and are less prone to damage than flexural strength specimens. This is an important consideration for specimens made at the jobsite that will have to be transported to the lab for testing. For these reasons, a relationship is developed between flexural strength and compressive strength by laboratory testing. Compressive strength test results can then be used to estimate the flexural strength by the formula:

$$MR = k\sqrt{f_c}$$

MR = modulus of rupture or flexural strength, in MPa or psi

f_c = compressive strength, in MPa or psi

k (metric) = constant, usually between 0.7 (for rounded aggregate) and 0.8 (for crushed aggregate)

k (in.-lb) = constant, usually 9 to 11

Approximate correlations between compressive and flexural concrete strength (for the case where k = approx. 0.74, metric [k = 9 in in.-lb units]) are listed in Table 4-6a, b.

Evidence of the relationship between compressive strength and square root of the flexural strength is seen graphically in Fig. 4-8, which shows long-term data for a number of concrete mixtures.

Following filling or sealing, a joint that is moving could exceed the filler extensibility and lead to a separation at the joint wall (adhesion failure) or within the filler (cohesion failure). When filler separation occurs, the voids should be refilled with the same original filler or a companion material supplied by the same manufacturer. If the filler becomes loose to the touch, it should be totally removed and replaced. Separated sealants must be removed and replaced.

Isolation joints, which are designed to accommodate movement, can be filled by removing ("raking out") the top portion of the premolded compressible material, then filling the cavity with an elastomeric material. Alternately, a premolded joint former with a removable insert can be used to provide the reservoir for the sealant.

If joints do not function properly, there may be edge spalling at the joint face, or random cracks may appear in the slab. The greatest portion of floor repair and maintenance is for joint edge deterioration and crack correction. See Chapter 10 for information on repairing joints and cracks.

Fig. 6-12. Cut-away view (core) of a joint showing the reservoir that will accept a joint filler. (69659)

DISTRIBUTED STEEL FOR FLOORS ON GROUND

Table 6-3. Reinforcement for Floors on Ground

Is reinforcement necessary?	
NO	• With uniform support and short joint spacing
YES	• When long joint spacing is required • When joints are unacceptable in floor use

Distributed steel refers to welded wire fabric or reinforcing bars placed in concrete slabs. The relatively small amount of steel is used to hold together fracture faces when (random) cracks form. Floors that contain steel bars or fabric are referred to as reinforced slabs (see Fig. 6-13). When floor joints are spaced less than 4.5 m (15 ft) apart, distributed steel is not needed in concrete floors on ground unless cracks must be tightly held together. Normally, short panel lengths will control cracking between joints. The short panels will reduce the total shrinkage in any one panel to a small enough value that the contraction joint may be satisfactory to assure aggregate interlock.

In slabs with long joint spacings, the purpose of distributed steel is to hold random intermediate cracks tight. Floor designers should therefore be aware and should accept that random intermediate cracks may, can, and do occur on concrete slabs having long joint spacings and containing distributed steel.

Since critical flexural stresses occur in both the top and bottom of concrete floors, steel should be placed in two layers to best resist stresses. Though two layers of steel may be ideal for resisting stress, double layers of steel are not always economically justified, and there may not be enough space to accommodate two layers. Ease of placement, or "constructibility," should also be considered.

Distributed steel can minimize the number of joints required in floor slabs, especially when long joint spacings are selected. Cracks due to restrained contraction or curling may occur, but sufficient amounts of distributed steel will hold the cracks tightly closed to permit load transfer through aggregate interlock.

Distributed steel does not prevent cracking, compensate for poor subgrade preparation, or significantly increase load-carrying capacity of the floor. Distributed steel reinforcement, both wire mesh or bar mats, should be terminated (cut) within 50 mm (2 in.) of both sides of con-

Fig. 6-13. A reinforced slab containing plate dowels and a mat of rebar. (69617)