

the crushing strength of cubes and slabs. It is probable that the effect of the pressing surface is so great as to completely mask the variation due to height of specimen. More experiments on this subject are very much needed.

**16. TRANSVERSE STRENGTH.** When stones are used for lintels, etc., their transverse strength becomes important. The ability of a stone to resist as a beam depends upon its tensile strength, since that is always much less than its compressive strength. A knowledge of the relative tensile and compressive strength of stones is valuable in interpreting the effect of different pressing surfaces in compressive tests, and also in determining the thickness required for lintels, sidewalks, cover-stones for box culverts, thickness of footing courses, etc.

Owing to the small cross section of the specimen employed in determining the transverse strength of stones,—usually a bar 1 inch square,—the manner of dressing the sample affects the apparent transverse strength to a greater degree than the compressive strength (see § 13); and it is even more unfortunate, since the strength of the stone as used in actual practice is nearly proportional to the strength of sawed samples.

The following formulas are useful in computing the breaking load of a slab of stone. Let  $W$  represent the concentrated center load *plus* half of the weight of the beam itself, in pounds; and let  $b$ ,  $d$ , and  $l$  represent the breadth, depth, and length, in inches, respectively. Let  $R$  = the modulus of rupture, in lbs. per sq. in.; let  $C$  = the weight, in pounds, required to break a bar 1 inch square and 1 foot long between bearings; and let  $L$  = the length of the beam in feet. Then

$$W = \frac{2bd^2}{3l}R = \frac{bd^2}{L}C.$$

The equivalent uniformly distributed weight is equal to twice the concentrated center load.

Table 3 on the following page gives the values of  $R$ , the modulus of rupture, and of  $C$ , the co-efficient of transverse strength, required in the above formulas.

*Example.*—To illustrate the method of using the above formulas, assume that it is desired to know the breaking load for a limestone slab 3 inches thick, 4 feet wide, and 6 feet long. Then  $b = 48$ ;

TABLE 3.  
TRANSVERSE STRENGTH OF STONE, BRICK, AND MORTAR.

MATERIAL.	MODULUS OF RUPTURE			CO-EFFICIENT OF TRANSVERSE STRENGTH.		
	Max.	Min.	Aver.	Max.	Min.	Aver.
Blue-stone flagging.....	4,511	360	2,700	251	20	150
Granite.....	2,700	900	1,800	150	50	100
Limestone.....	2,500	140	1,500	140	8	83
“ oölitic, from Ind., sawed.	2,590	2,190	2,338	144	122	130
Marble.....	2,880	144	2,160	160	8	120
Sandstone.....	2,340	576	1,260	130	32	70
Slate.....	9,000	1,800	5,400	500	100	300
Brick (§ 59).....	1,796	269	800	100	15	45
Concrete—see § 156.....						
Mortar, neat Portland, 1 year old..			1,158*			64*
Mortar, 1 part Portland cement, 1 part sand, 1 year old.....			945*			52*
Mortar, 1 part Portland cement, 2 parts sand, 1 year old.....			632*			38*
Mortar, neat Rosendale, 1 year old.	715	415	600	39	23	33
Mortar, 1 part Rosendale cement, 1 part sand, 1 year old.....	690	348	526	38	19	29
Mortar, 1 part Rosendale cement, 2 parts sand, 1 year old.....	479	338	405	26	18	22

$d = 3$ ;  $l = 72$ ;  $R = 1500$  lbs.,—the “average” value from the table;—and  $C = 83$ . Substituting these values, we have

$$W = \frac{2bd^2}{3l}R = \frac{2 \times 48 \times 9}{3 \times 72} 1500 = 6000 \text{ pounds;}$$

or, using the other form,

$$W = \frac{bd^2}{L}C = \frac{48 \times 9}{6} 83 = 5976 \text{ pounds,}$$

which agrees with the preceding except for omitted decimals. Hence the breaking load for average quality of limestone is 6000 pounds concentrated along a line half-way between the ends; the uniformly distributed load is twice this, or 12,000 pounds. The

\* Only one experiment.