

H A N D B O O K
OF
RAILROAD CONSTRUCTION;

FOR THE USE OF
AMERICAN ENGINEERS.
CONTAINING THE
NECESSARY RULES, TABLES, AND FORMULÆ

FOR THE
LOCATION, CONSTRUCTION, EQUIPMENT, AND MANAGEMENT OF
RAILROADS, AS BUILT IN THE UNITED STATES.

With 158 Illustrations

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"RULES THEMSELVES OBLIGE US TO REFLECT, THAT WE MAY SEE WHETHER WE HAVE NOT
DEPARTED FROM THEM." — NAPOLEON.

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CHAPTER XI.

MASONRY.

STONES.

262. THE varieties of this material most commonly used in engineering operations are granites, limestones, sandstones, slates, brick, and artificial stones; the latter being made by compounding clays, limes, and cements.

Rock taken from the surface, which has been exposed to the atmosphere, is of an inferior quality to that found at a depth where it has been exposed to a strong pressure; and is consequently denser. Therefore, in opening a quarry it is advisable to excavate upon a hill-side and come at once to the sound stone. Rock is generally found in beds, divided by joints or seams, at which the natural adhesion is broken and the layers are easily separated. When the quarry shows no natural line of separation, one may be produced by drilling a line of holes at equal distances from each other, into which conical steel pins are driven, and the stone splits; the pins being placed in the plane of the required seam.

263. Stone is used almost entirely to resist a compressive strain; as in the voussoirs of an arch, or in the courses of a pier. The resistance of stone to crushing, is as follows:—

| | Pounds per square inch. |
|-----------------------------------|-------------------------|
| Granite | 10,000 to 16,000 |
| Limestone | 12,000 to 14,000 |
| Sandstone | 10,000 |
| Marble | 9,000 to 14,000 |
| Firm, hard burned brick | 2,600 |
| Yellow burned brick | 1,500 |
| Red brick | 1,200 |
| Pale-red brick | 900 |
| Chalk | 750 |

264. When stone cannot be found, brick forms an excellent substitute; being made from clay earths, which can be found in almost any locality. Bricks are well fitted for nice work, are cheap, and easy of transport. The French, at Algiers, have used concrete, rammed in boxes so as to make large cubes and other shapes. The structures built of this material are found to be very nearly if not quite as strong as those of natural rock.

LIMES, CEMENTS, MORTARS, AND CONCRETES.

265. Nothing is more important in the construction of masonry than good cement; and generally, no part of construction is intrusted to more ignorant persons. Under the above head are to be considered limes, cements, sands, common hydraulic mortar, and concrete.

266. Lime is obtained by burning off the carbonic acid from the pure limestones; when it is put up in air tight barrels and is unslacked lime. Natural cements are composed of pure lime mixed with argyle magnesia, iron, and manganese. Artificial cements are prepared by mixing with pure lime, calcined clay, forge scales, powdered bricks which are underburnt, and other materials of like nature. Cements made thus artificially, are as good as those naturally hydraulic.

Lime is termed rich, poor, hydraulic, and eminently hydraulic, according to its properties.

Rich or fat limes are those which double their volume in slacking and dissolve in fresh water to the last particle. They absorb about 300 per cent. of their weight of water.

Poor limes do not much increase their volume, do not dissolve completely, and absorb 200 per cent. of water.

Hydraulic limes set in fifteen or twenty days after immersion, and continue to harden as they grow older. After one year their consistency is about that of hard soap.

Eminently hydraulic limes set in five or six days, and continue to harden.

Limes are said to set when they will bear, without depression, a rod of $\frac{1}{4}$ of an inch diameter loaded with ten or twelve ounces.

NOTE. — The following test was applied to every tenth cask of Rosendale cement used upon the masonry of the United States Dry Dock at the Brooklyn (N. Y.) Navy Yard. Cakes two inches in diameter and three fourths of an inch in thickness, after being immersed five days, were required to bear a rod of one twenty-fourth of an inch diameter loaded with fifty lbs. Two bricks united with the cement and immersed five days, were required to resist one hundred lbs. before separating. The following shows the progress of hardening. The force required to thrust a rod one twenty-fourth of an inch in diameter through a cake three fourths of an inch in thickness, was, after

| | | | | |
|-----------|---|---|---|---------|
| 24 hours, | . | . | . | 65 lbs. |
| 48 " | . | . | . | 70 " |
| 72 " | . | . | . | 75 " |
| 15 days, | . | . | . | 150 " |
| 50 " | . | . | . | 390 " |

SAND.

267. Sand is the product of the decomposition of granitic and schistose rocks, and weighs, per unit of bulk, somewhat less than one half of the rock producing it; owing to the spaces between the grains. The amount of lime necessary

to fill these spaces must be known before we can form a solid mass with the least lime. The amount of void may be found by filling a measure with sand, and then pouring in water: the volume of water is that of the spaces. In pebbles of one half inch in diameter the void amounts to about one half, in gravel about five twelfths, in common sand two fifths, and in very fine sand, one third. Clean sharp sand obtained from the beds of rivers is the best for mortars.

268. In mixing the ingredients for mortar, the lime is first spread on a platform and wet by sprinkling with water, which causes it to give off a great deal of heat and vapor, and fall into a powder. The sand is then applied, and the whole brought with water to a consistent paste.

The proportions for common mortar for dry work are

| | | | | | | |
|-------|---|---|---|----------------|----|---|
| Sand, | . | . | . | $7\frac{1}{2}$ | to | 2 |
| Lime, | . | . | . | . | . | 1 |

It is well always to use a small quantity of cement; the parts which have in practice been found perfectly satisfactory are

| | | | | | | |
|---------|---|---|---|---|---|---|
| Cement, | . | . | . | . | . | 1 |
| Lime, | . | . | . | . | . | 3 |
| Sand, | . | . | . | . | . | 6 |

For hydraulic mortar the following proportions have been used with success:—

| | | | | | | |
|---------|---|---|---|---|---|---|
| Cement, | . | . | . | . | . | 2 |
| Sand, | . | . | . | . | . | 3 |

269. Concrete is made by mixing broken stone, brick, or shells, with cement mortar; it is used for foundations, backing of arches, and for making artificial stone. The common proportions are

| | |
|-----------------|---------|
| Cement, . . . | 1 or 2 |
| Sand, . . . | 1½ or 3 |
| Broken stone, . | 5 or 10 |

The cement and sand are first mixed as for cement mortar; the broken stone is added and the whole well mixed and immediately applied before it has time to set. Both concrete and cement mortar should be made as required for use, and in no case applied after standing over three hours.

FLASHING MORTAR.

270. Flashing consists of a thin coat of cement mortar made with a very large part of cement. It is used to protect the face of walls exposed to the wet; such as the top of arches. Stone liable to disintegration may be protected by flashing.

POINTING MORTAR.

271. Pointing is used to protect the joints of masonry, and is made by mixing cement and sand with a minimum of water. The joint is first cut out to the depth of from one half to one inch, carefully brushed clean, moistened with water, and filled with the mortar, which is well rubbed with a steel tool. To give architectural effect, plaster of Paris (Gypsum) is sometimes used in pointing.

GROUT.

272. Grout is thin-tempered mortar, composed almost entirely of cement and water. It is run into the joints, and is useful in filling crevices in masonry which cannot be filled with mortar.