THESIS

METHODS AND COST

of

STONE DRESSING

By

R. J. Cooke.

DEGREE

B.S.

1890

SCHOOL

C.E.
Introduction.

The practical operations connected with stonework of various kinds may be treated under the head of "Work on Stone," i.e., the work put upon stone, before setting, by the stone-cutter and other masons.
Definitions.

A mason, properly speaking, means a builder; but in England it is customary to look upon a mason and a stone mason as one and the same, a builder in bricks being always called a brick-layer. In Ireland the term masonry is specially applied to stone walling as distinguished from the cut stonework used in dressings and other work of superior description.

In general terms, the O'Hara Department Schedule for Mason's Work are intended to provide for the execution of all the stone-work required in the erection and fitting up of O'Hara Department buildings, including providing the stone in block, working and dressing it up as may be required and setting it in its place; though hoisting above 30
First is generally paid for as extra.

Under the head of Masonry Work may be included that of the stone-cutter, granite mason, freestone mason, marble mason, carver, and wall or rubble-mason, or waller.

In order to be a good judge of masonry, both as regards the quality and cost, it is necessary to be familiar with the materials employed and the treatment they undergo, from their position in the quarry to their final setting in the building.

Dressing stone implies putting any particular description of work or finish upon its surface, after it has been brought to the required shape. There are many methods of dressing stone, differing according to hardness and the custom of the locality, the
same description of work being frequently known under distinct names in different places; however, the following explanations embrace the principal kinds of work on ordinary building stones, and the terms most commonly used.

Limestone is the name given to such building stones as admit of being freely worked by the mason with his mallet and chisel, and consequently apply to the greater number of sand and limestone.

The stones intended for the cut-stone work in a building are brought to the mason's bench in blocks of the required dimensions, either scabbled or sawn, as the case may be.
Methods of Hand Dressing.

The manner of dressing stone belongs to the stone-cutter's art, but the engineer should not be inattentive either to the accuracy with which the dressing is performed, or the means employed to effect it.

The usual manner of dressing a surface is to cut draughts around and across the stone with a chisel, and then to use the other tools as necessary, to work down the intermediate portions to the same surface with the draughts. In performing this last operation, the chisel and axe should alone be used for soft stones, as the grooves on the surface of the hammer are liable to become choked by a soft material, and the stone may in consequence be materially injured by the
repeated blows of the workman. In hard stones this need not be apprehended.

Softer stones are always finished to a much smoother face than harder stones, as any attempt at producing an effect by roughly dressing them would soon be effaced by the action of the weather. Generally the only dressing bestowed on them is dragging them with a drag or comb, to get rid of the inequalities left by the saw or chisel. The drag used may be pieces of an old saw, with coarse or fine teeth according to the smoothness required. Some stones which are too tough and chesy for dragging, are shaved with a common carpenter’s chisel, as in wood carving. In dressing the surface of soft stones there is no scabbling, chiselling,
rubbing, etc., though chisels are used in shaping the stones and working moldings.

In dressing hard freestone, there are many varieties of surface-work, the name given to them differing very much with the locality. The following, however, may be taken as those frequently put upon the harder kinds of freestone; the dressing of soft freestone being a much simpler matter.

**Splitting Stone.** This method may be used in either hard or soft material, but in either case the large blocks are split up by striking notches or holes along the proposed line of fracture, at distances apart varying with the obstinacy of the stone, and driving gade and wedges of iron into them, or by means of iron plugs and feathers.
The holes are either sunk with a jumper, a long bar of iron with a steel cutting edge like a chisel, worked by one man, who merely raises it, turns it slightly, and lets it fall; or with a similar but shorter bar, called a boring bit, which is held and turned by one man, while another keeps up a succession of blows upon it with a heavy sledge of about fourteen pounds, or a boring hammer of about ten pounds. Single-hand boring bits and hammers, light enough to be both worked by the same man, are also used when the stone is not too hard.

Most stones have certain planes of cleavage along which they split more readily than in other directions, and these planes are chiefly known to quarrymen by their...
direction with reference to the natural joints and lines of stratification, if any, in each particular quarry. Some stones may, while green or fresh from the quarry, be easily split up by cutting a fine line with an ax in the direction required, and then giving the stone a few smart taps with the hammer.

Scabbling Stone.—The stones having been got out of the quarry, are reduced to a closer approximation of the required dimensions by scabbling, or roughly dressing them with the scabbling hammer, or the spalling or quarry mains hammer; the scabbling hammer for granite weighing 22 pounds, and having one flat or spalling face of about 4½ by ½ inches for knocking off the irregular angles, the
other being fish-faced, or pointed, for the purpose of reducing the surface irregularities.
This work is generally done at the quarry in order to reduce the cost of carriage.
At the quarries of the Southern Illinois Penitentiary the work is done entirely by hand, and the method used is to first point the stone down to a level surface, then draft it with the tooth-chisel, then plain-chisel, then tooth-axe, then bush-hammer to a level surface.
Sawing. The more valuable stones, when they will admit of it, are sawn into slabs and scantlings, either by hand or by machinery.
In the case of hard stones, such as granite, marble, etc., a toothed circular saw, sometimes slightly jagged at the edge,
is employed, which when drawn backwards and forwards cuts the stone by its own weight, the operation being greatly facilitated by some clean sharp sand which is carried into the saw cut by water trickling down an inclined plane. Granite is sometimes sawn into slabs for panels, tables, and chimney pieces; it is a very tedious operation, the rate of progress by the ordinary hand process being about 1/2 inch per day of ten hours.

Blocks of soft stone are sawn into scabblings by means of an ordinary two-handed toothed saw; or, for small pieces, a common carpenter’s saw is often employed.

Hammer Dressing. The rougher description of work after scabbling is hammer dressing. This consists of getting rid of any
irregularities on the surface of the stone, with a much lighter hammer than the scabbling hammer, one face being flat for roughly shaping the stone, and the other axe-shaped for smoothing or hammer-dressing the surfaces. It generally goes by the name of wacker's hammer, and is capable of being used with either one or two hands as may be required.

**Half-Plain Work.** This term is applied in War Department Schedules to such work as to the joints of cut stone work, when left as they come from the saw; or to roughly picked or hammered surfaces brought to a sufficiently smooth condition for ordinary joints, by dressing them down with a punch or point, leaving the marks of the
tool all over the surface. In preparing
joints, any irregularities left by the joint, above
the plane of the joint, are finally dressed
down with a chisel or boaster.

Plain Work. Plain, chiselled or random-
tooled work is simply chiselling down the
irregularities left by the saw, punch, or
joint, leaving the chisel marks running
at random all over the surface of the
stone. The broader the chisel used, the
smoother will be the surface.

Pointed Work. In Scotland this is called
dabbed work. It consists in bringing the face
of the stone to a regular surface by pick-
ing them all over with the point, the marks
of the tool running generally in lines at
right angles to the bedding of the stone,
or at random when the stone has no distinct bedding. It has a pock-marked appearance, may be worked to a great degree of fineness, and is always chisel-draughted around the margins.

When worked to a coarser surface, with a punch, it is called punched work.

**Boasted Work.** Boasted work is a description of more regular chiselling, in which the marks of the tool run in parallel lines, each successive stroke being made beneath the last, down the whole length of the stone. The same operation is repeated until the marks extend over the whole breadth.

**Tooled Work.** This is similar to the last, except that each stroke of the tool is made by the side of the last, so as to form a
series of parallel lines, each line extending across the whole breadth of the stone. It is, however, much more troublesome to do, as the surface has first to be worked smooth with a chisel.

**Stroked, or Striped Work.** This kind of work is similar to tooling, except in the direction of the lines, which run at an angle of about 45°, instead of parallel to the edge of the stone.

**Rubbed, or Polished Work.** This method is applicable to plain work rubbed down with freestone, sand, and water, to a perfectly smooth surface. In preparing the surface for rubbing, it should be pointed to as true a face as possible, and then dressed smooth with a bolster or broad tool; or the latter
only will suffice if the stone is soft.

Marble is polished by being rubbed with a grit or sandstone, then with pumice stone, and finally with emery or calcined tin. The rubber is about 3 inches square, of ¼ to ½ inch felt cemented to a rich piece of wood, so as to give a good hold to the hand.

**Inspection.** Masons are apt to scamp cut stone work by disguising cracks, chipped edges, and waists or hollows in stones, by means of a composition, instead of working down the whole surface of the stone below such imperfections. For this purpose they will pound up a piece of stone and mix the stone dust with melted resin or balsam, which when pressed into the hollow will soon harden and admit of being worked
like the rest of the stone. With some of the harder stones some of the dust is mixed cold with shellac and naphtha to fill up any imperfections, and pieces are sometimes even joined together with shellac and naphtha. A little careful examination will generally detect such tricks as these.

Hogmen, unless narrowly watched, seldom take the pains necessary to dress the bed and joints accurately; on the contrary, to obtain what are termed close joints, they dress the joints accurately a few inches only from the outward surface, and chip away the stone towards the back, so that, when the block is set, it will be in contact with the adjacent stone.
only throughout this very small extent of bearing surface. This practice is objectionable from every point of view; for, in the first place, it gives an extent of bearing surface, which, being generally inadequate to resist the pressure thrown on it, causes the block to splinter off at the joint; and in the second place, to give the block its proper set, it has to be propped beneath by small bits of stone or wooden wedges, an operation termed pinning-up, or under-pinning; and these props, causing the pressure on the block to be thrown on a few points of the lower surface, instead of being equally diffused over it, render the stone liable to crack.
Methods of Machine Dressing.

Although the conversion of stone is one of the most ancient of all the mechanical arts, its conversion by means of machinery, in an advanced form, is quite of modern origin. A few years since, owing to the high rate of wages in vogue, to operative masons striking, and to other causes, a very considerable impetus was given to the development of this branch of engineering; however, in consequence of the continued depression in everything relating to the building industries, the introduction of machinery for the conversion of stone has been very slow. This may be partly attributed to the fact that in one or two cases machinery was erected in
which the principle of working was ill-adapted to the nature of the stone operated on, and partial failure was the result. There can, nevertheless, be but little doubt that by judicious selection, machinery can be made to effect an immense saving over hand-labor.

In the first place, it is important that the stone it is desired to work be suitable for machine conversion.

Most kinds of freestone can be readily worked by machinery if they are tolerably free and even in texture and hardness. Hard gritsandstone, magnesiaum limestone, dolomite, and granite may be dressed by machinery to a plain surface. Slate, unless it be rotten or shaly in character, may be worked by machinery
with facility. In the Potsdam Red Sandstone of Potsdam, New York, no machinery for dressing has as yet been used. Planers and lathes will not work this stone on account of its hardness and strength. The company proposes trying this season some of the tools manufactured by the American Pneumatic Tool Co. of New York City. If these tools can be used to advantage, a number of them will be used.

Stones which contain much shelly fossil deposit, especially if this be hard and crystalline are not readily reduced by machinery, as also are very tender stones. From a casual inspection of a stone, however, it is impossible to say with certainty whether it can be dressed by machinery. The best way is to try it practically.
Sawing. Most kinds of stone can be sawn without much difficulty; but when they are required to be dressed to a fine surface, or moulded, difficulties, varying with the character of the stone, present themselves. There are two kinds of saws employed, (1) the straight horizontal blade, and (2) the circular saw.

Horizontal Blade. The operation of sawing stone with a straight blade involves two motions, viz. a horizontal to-and-fro motion, which does the cutting, and a vertical motion which feeds the saw down into the stone. The latter is effected by means of a suspended boom, the whole system moving within a fixed frame or stand. The sawing or cutting operation is effected through
the friction of the saws along the stone by distributing sand and water along the rubbing surfaces.

The machine consists of four timbers about 9 inches square, and about 12 ft high, which are driven into the ground at sufficient distance to make them comparatively solid, and are united at the top by cross timbers and by outside diagonal timber bracings, forming a compact and solid stand. Between the stand, and fixed to the top cross timbers, is vertically suspend ed a timber called the swinging boom. Between the stand moves the saw-frame, which is suspended at its four corners to the stand by means of chains. On the top are the necessary pulleys and drums.
The sawing frame consists of two longitudinal cast-iron arms, about 12 feet long and 4 inches deep, which are provided at their ends with longitudinal openings to receive two wrought-iron bores, which are about 6 feet in length, 2.5 inches in breadth, and 2 inches in thickness, between which the saws are keyed. One end of the saw-frame on each side is provided with a small arm bearing a slide-piece, which serve as its guide and connection by sliding in the vertical slotting which is fixed to the swinging boom, and comes into action by the downward and upward motion of the saw-frame. The forward and backward motion of the saw-frame, which is connected through
slide pieces to the swinging boom, is effected through the connection of the latter with a steam engine, or to a main shaft driven by an engine.

The saws are of malleable hammered iron, about 8 feet long, and 5 inches wide, by \( \frac{1}{8} \) inch thick, plain faced without teeth. There are from four to ten saws, and sometimes even more, in one frame.

The blocks to be cut are either carried to the machine by trucks moving on rails, or are placed in position by means of steam engines.

Gang Saws. The Merriman gang saws, screw feed, planers, the same as are used for planing iron, and heading machines, are quite extensively used at present by the
Young and Farrell Diamond Stone Sawing
Co. of Chicago. Quite a number of ma-
chines of various devices for cutting stone
have been patented in England; also end-
less wire gauge in Belgium, but of the
practical workings of them little can be
said.

The method adopted by the Bedford
Steam Stone Works of Bedford Indiana
is as follows: The stone is cut in the
quarries by channeling machines; after
which the stone is then quarried out in
blocks containing from 50 to 200 cu. ft.;
then these blocks are sent to the mills
where they are sawed into slabs of any
thickness desired. The sawing is done by
means of gauge which move backward.
and forward, and feed down by means of a large screw, which is fed automatically by the gearing coge. The saw-blades are simply bands of iron of the length of the gang, and four inches wide by \( \frac{1}{8} \) inch thick. Any number of blades can be put in a gang, from one to thirty, according to the number of cuts wanted. It might be well to state here that these gangs cost about \$1200 each, and require about 8 horse power for each gang. The cutting is done by means of sharp sand which is washed under the saw-blades by a continual flow of water, and the swing of saws backward and forward causes them to lift, and the sand gets under the blade which strikes and causes the sand
to cut its way into the stone. No certain amount which a gang will cut in a day can be specified. The softer the stone, the faster, of course, will be the cutting. In the hardest of Bedford stone, 3/4 inches per hour can be sawed; while in the softest from eight to twelve inches.

**Circular Sawing.** For rapid sawing of the softer stones used in building construction, the circular saw has quite outpaced the ordinary horizontal blade. With a well-constructed machine of this class, from 150 to 200 running feet can be cut in a day of ten hours; if two saws are mounted side by side, they can be used for squaring the faces of the blocks at the rate of from 3 to 9 inches run per minute, and for
this purpose they are of very considerable value. The advantages in favor of the blade horizontal, are low first cost and rather cleaner work. The most important point in connection with circular saws for stone working, is the construction of the teeth; these, which are usually "false," should be of simple form, and easily and cheaply renewed. After repeated trials, those with the heads of the teeth forged into a cupped or trumpet form are recommended; they should be made from the best red steel, turned at the cutting edge and hardened. One of the advantages of this form of tooth or cutter is, that when its edge is dull or chipped, it can be turned in its socket so as to offer a fresh cutting margin, and
as it wears away on the advancing side, the tool will offer several fresh cutting faces before it is entirely worn out. The tool should be made sufficiently long, so that it will allow of its head being softened again set up, turned, and hardened.

As regards the cutting speed of circular saws for stone, no definite rule can be laid down, as this much depend on the nature of the stone operated on. A speed at the periphery of from 50 to 200 feet per minute, or with a cutting-speed varying from 1 inch to per minute, in hard stone, up to 1 inch per minute in soft stone will be suitable. In cutting very difficult stone, such as that containing pyrites, the cutting tool should run very slowly indeed, say 40 ft.
traverse at the periphery per minute, or they will be found to heat red-hot, and will of course be rendered useless; the feed should not exceed two inches per minute.

Some difference of opinion exists as to the advisability of sawing stone with circular saws with or without water. Some stones can, without doubt, be sawn dry, but it has been proved that wet sawing is preferable, as it keeps the tools cool and prevents unnecessary dust. In cutting stone with circular saws the strain on the sawspindle and bearings is considerable; they should, therefore, be thoroughly supported by massive side standards, and the bearing surfaces should be ample; the whole framework of the machine should be of massive
construction, to overcome excessive vibration in working. Should there be a jar on the saw teeth in working, they will be found to deteriorate much more rapidly, and the work turned out will be "galled," and not so true on the face.

With a well constructed circular saw the stone should leave the machine sufficiently true to enable it to be bedded or jointed without further preparation, either by hand or on the planing machine or rubbing bed.

For rapidly squaring large blocks of stone for harbor and similar works, circular saws will be found especially valuable, and as they become better known, their use should be largely extended.
For dividing very large blocks, two circular saws, placed one above the other, but working in the same vertical line can be used.

For joining flat stones, such as paving, all hand labor may be saved by mounting two saws so as to trim two edges and make them parallel, and by reversing the stone and setting it square by these sides, the other edges may be served in a similar manner.

Planning. This is done by powerful circular sawing machines having two horizontal saw discs. The machine consists of a strong cast-iron frame to receive the requisite gearing. The discs are carried on vertical spindles and revolve horizontally. A strong vertical table can be moved backwards and forwards over the bed which carries the stone. The saws are...
adjustable vertically to suit the work. The saw disc has on its circumference a number of receptacles, into which the cutting tool is driven, the latter being a kind of steel nail, the head of which is shaped like that of a counter-sunk rivet, the edge of the conical head being the cutting surface. The stone is worked by the two saws from both sides. The machine is especially used for converting the blocks coming from the quarry into slabs or pieces of any size, and for squaring and facing them. These machines are constructed to work any size of stones, but are generally made for working stones of an average size from $6 \times 3 \times 3$ ft., to $9 \times 4.5 \times 4.5$ ft., and requiring from 2 to 3 horse power to drive them. There is no doubt some waste of material, but this
loss seems to be compensated for by using the dust for polishing the stones in the surfacing and rubbing tables. The stone moldering and planing machine is provided with the same shaped steel cutters, placed in a series of tool holders, fixed either on horizontal or vertical shafts. The stone is carried on a bed, plate or travelling table moving backwards and forwards. A horizontal or vertical shaft called the cutter barrel, bears a series of tool holders carrying the steel cutters, which are so arranged that the diameters of the different series of tools correspond to the outline of the required molding. The tool holders are placed vertically on the horizontal shaft and horizontally on the vertical shaft. The stone faces slowly by the cutters at the
rate of about 4 inches per minute. To finish the work the cutter-shaft is raised, and a steel scraper of the exact form of the molding is passed 3 or 4 times over the stone at an increased speed of about 12 in per minute.

The machine with the horizontal cutter works stone from about $6 \times 2.5 \times 2.5$ ft. to $9 \times 4 \times 3\frac{3}{8}$ ft., with an average of from 2 to 3 horse power.

The machine with the vertical shaft is adapted for working smaller stones, such as steps and sills. The surfacing and rubbing table are composed of a strong revolving iron disc fixed to a vertical shaft. A circular iron trough is placed around the disc to catch the waste sand and water used. Timbers fixed above the disc divide it into compartments, in each of which a stone block
can be placed, being held by the timbers while the disc revolves. The table can, as stated before, from 8 to 14 feet in diameter, requiring from 3 to 6 horse power to drive them.

Molding. Although the advantage of machinery conversion over hand-labor in stone sawing is considerable, it is much greater in the case of stone dressing and molding machines.

In the early machinery it was attempted to imitate mechanically the action of the mason's chisel or quarry-axe, but the whole of these devices have been failures. The principle of working that has proved most successful in dressing plain surfaces on stone is that of circular rolling cutters, and for molding stone, a combination of revolving
For dressing plain surfaces the circular cutters are given a determinate rotation on their own axes at the same time that they are carried round in a circle.

It is found that with a nicely adjusted rolling action there is very little attrition between the stone and the cutter, and that this is due chiefly to the forward movement of the stone; at the same time little heat is produced, and the cutter edge wears away very slowly. The principle of working may be stated as a rolling pressure brought to bear upon the base of a certain portion of stone with the intent to force it off. These cutters are made of chilled cast-iron, or, for working the harder kinds of stone, of chilled...
cost steel; the cost of renewal is small. A variety of machines have been constructed, in which a number of tools of various type, having a circular movement in a plane parallel to the face of the stone, are employed. To successfully work them mechan-ically over the face of the stone may not appear very difficult in theory, but in practice it is invariably found, when a large number of tools are employed, that they vary in wear from difference in temper, material, or from the work they have to perform; and this is, without doubt, one of the chief reasons of the failure of this class of machines, whether for working stone, wood or other material.

The amount of stone that can be dressed
on the best type of machine will depend largely on (1) the nature of the stone being worked,
(2) the size of the blocks, and (3) the way in which the machine is kept constantly sup-
plied with stone.

With the ordinary stones used in building construction of a moderate degree of hard-
ness, a fair average would be about 30 sq. ft. per hour, presuming, however, that only a
moderate amount of stone had to be removed.
The cost of this, allowing two men and a
boy to supply stone and attend to the machine,
would amount to about 50%, while an av-
earge price to dress the same by hand,
would be about $1.25, leaving a large profit
and accoutrements for contingencies. These prices
would, however, vary somewhat in different localities.
Rubbing, or Surfacing. As one of the most useful and economic machines for the conversion of stone the rubbing-bed or surfacing machine has of late years come into peculiar notoriety. The saving in time and labor by the use of these machines is a fact beyond dispute, and the increasing favor in which they are held is demonstrated by the call for larger machines. When first introduced, machines of this description, with revolving tables of 7 ft. 6 in., or 9 ft. diameter were, for the most part, employed. Then, when their utility had been fully established, and large contracts which required an immense quantity of stone to be manipulated, machines with tables of 11 ft. diameter were required. This was again increased to 13 ft., of which
size many machines have been made. More
lately the 13-foot machine with the large rub-
ing surface which they possess have been found
insufficient; and machines with tables of
14 feet diameter have been manufactured, and
for such a large machine, has proved quite
successful. Means are employed to secure the
greatest steadiness when revolving; and the
quantity of rough stone that can by this means
be surfaced to a perfectly even finish places
the stone rubbing-bed in the front of
marble machinery.

Stone-working machinery will be more
used than it is. Machinery for sawing, mold-
ing, polishing, and surfacing stone, marble
and granite, has worked its way into many
yards. Stone and marble sawing machines
with timber framing, or of various size, to take in blocks of stone or marble up to 10 x 8 x 6 ft. or larger, if required. Blocks are cut into any number of pieces, as may be wanted. The vibrating frame is strong, made, and provided with convenient means for setting the saw-blades, the number of which may vary from one to twenty-eight. The pendulum, giving motion to the vibrating frame, is arranged so that the latter can be worked through blocks of stone of considerable depth. The rubbing-bed or surfacing machine is one of the most useful that a stone mason can employ. The revolving top is made of a select mixture of cast-iron; the diameter as stated before, varies from 7 ft. 6 in. to 14 ft. according to the requirements of the purchaser.
The stones, in their rough condition, are placed on the bed of this machine, and there receive a true and smooth surface, no matter how hard the stone may be.

Cost.

Hand Work. A stoncutter will first take out of mind, and then fairly paten hammer dust about 8 to 10 sq. ft. of plain face in hard granite in a day of eight working hours; or twice as much of such inferior dusting as is usually bestowed on the bed and jointing, and generally on the face also of bridge Masonry, &c., when a very fine finish is not required. In good sandstone or marble, he can do about one fourth more than in granite. Of finest hammer finish, in granite he can do about 40 oz. sq. ft.
In hard limestone such as is quarried at Alton for rough bush-hammered work the stonemason receives 25%; for medium work, 30%; and for fine, 35% pr. ft.

The Halleaum Stone Co. in Henderson Co. in this state do scarcely any other but ¼ inch joints, for which is paid, for plain work, 30% pr. ft. Bush-hammered, mouldings, and other ornamental work, they say can only be cut at guess work; Jarties engaged in this one, as a rule, estimate very closely about what such work will cost, judging from the character of the details.

The Kaukaoe Stone and Lime Co. do only hand work. They say "with wages at $3.00 a day the cost of dressing limestone (bush-hammered or dress work) is about 25% for surface ft."
At the Southern Illinois Penitentiary where only hand work is done, the cost of dressing from the rough is about 60% for ft., face measure, for limestone; and 40% for sandstone, but if drove all over, about 80% for lime, and 60% for sandstone.

The actual cost of dressing such limestone as is quarried at Grafton is $4.50 to $5.00 per cu. yd., for bridge stone, or from 18 to 20% per sq. ft. for bush-hammered work.

The cost of sawing Bedford stone is about 20% per cu. ft. The cost of quarrying is also about 20%, and the cost of cutting depends upon the price of labor — stonecutters wages varying from $3.00 to $6.00 per day.

Machine Work. The art of stone-cutting is so diversified in its application and
and use in construction of buildings, large
piers and retaining walls for bridges and
dams, and its adoption in monumental
works, that it is next to impossible to make
a price, even approximately, which could be ap-
plied in practice; such knowledge can
be obtained only by practical training and
experience.

The introduction of machinery for saw-
ing and cutting stone since the last thirty
years and its improvement during that
time to its perfection as at present in use,
as well as the rise of stonemasons' wages
from that time to the present (fully 100%)
are the factors which make the difference
in dressing between the two systems of 66% on
present conditions.
The Young and Farrell Diamond Stone Sawing Co. of Chicago classify the material into three grades: viz: soft, medium, and hard. The term soft would include all Iron or Sandstones; medium, Limestone - Magnesian and Dolomite; and hard, Marble and Granite. The cost of sawing soft would average from 8 to 10 cents per sq. ft. of clear face work, or two cuts to the cubic foot.

The cost of planing the stratified limestone as it is found in this state does not exceed 12 cents per sq. ft. The cost of hand dressing of the above stone is as follows: soft, from 25 to 35 cents per sq. ft.; medium, from 40 to 45 cents per sq. ft.; and hard, from 75 to 80 cents per sq. ft. of clear face work, the price of labor...
estimated at the rate of $2.40 per hour, which is the rate paid in Chicago at the present time. The cost of the hard in which granite is included is considerably less in the Eastern Sea-Coast States, as the wages of granite cutters are only about half that of stonecutters as before quoted, in the states of Maine, Massachusetts, and New Hampshire. No regular system of estimating on mouldings or other irregular work in the two first-named grades is in practice, as the cost of such work depends largely upon the contour of the face and its projection from the wall, but ordinarily is about twice the cost of plain work. In granite cutting there is a system in vogue of estimating on mouldings per linear foot.
of each member of the face.

The Syenite Granite Co. of Graniteville, Mo., furnished about 36,000 cu. ft. of granite for the Merchants Bridge at St. Louis. It was cut in courses from 24 to 30 inches thick, and to 3-inch joint, and was delivered in St. Louis at $1.50 per cu. ft. The actual cost for cutting, bedding, and joints in this work of this character, as estimated by the company, is about 20 per superficial foot, independent of all con-tiguity expenses such as blacksmithing, handling, etc., which generally average about 30% of the cutting.

The blocks of granite for Bunker Hill Monument averaging two cu. yds. each were quarried by wedging, and delivered at the site of the monument, at a net actual
cost of $5.40 pr. cu. yd. The actual cost of getting out the rough blocks at the quary was $2.70.

In 1886, granite block about a cu. yd. each, with dressed bide and joints, but with only a 2-inch draft around the showing face— which is left rough—were delivered on the wharf at Philadelphia from Port Deposit Md. at $16 each.
The rate of sawing is shown by the following table.

<table>
<thead>
<tr>
<th>Material</th>
<th>Locality</th>
<th>Cutting Agent Used</th>
<th>Depth of Cut in 10 Hours</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>Addison, Me.</td>
<td>Chilled Shot</td>
<td>10 in.</td>
<td>4 saws.</td>
</tr>
<tr>
<td></td>
<td>Red Beach, &quot;</td>
<td></td>
<td>7 1/2&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chester, Mass.</td>
<td></td>
<td>12&quot;</td>
<td></td>
</tr>
<tr>
<td>Bluestone</td>
<td>Hudson River</td>
<td></td>
<td>8&quot;</td>
<td></td>
</tr>
<tr>
<td>Marble</td>
<td>Carrara, Italy</td>
<td></td>
<td>13&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tennessee</td>
<td></td>
<td>9&quot;</td>
<td>45 saws.</td>
</tr>
<tr>
<td></td>
<td>Tate, Ga.</td>
<td></td>
<td>6&quot;</td>
<td>40 saws.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gouverneur, N.Y.</td>
<td></td>
<td></td>
<td>10 saws.</td>
</tr>
<tr>
<td></td>
<td>W. Rutland, NH.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proctor, NH.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>New Point Ind.</td>
<td>Sand</td>
<td>Depth</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------</td>
<td>-------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>Blank</td>
<td>Blank</td>
<td>10 in</td>
<td></td>
</tr>
<tr>
<td>Bedford Sand</td>
<td>&quot;</td>
<td>&quot;</td>
<td>15 in</td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>15 &quot;</td>
<td></td>
</tr>
<tr>
<td>Magn. Limestone</td>
<td>&quot;</td>
<td>&quot;</td>
<td>14 saw</td>
<td></td>
</tr>
<tr>
<td>Sandstone</td>
<td>N. Anheirt, C.</td>
<td>&quot;</td>
<td>12 saw</td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>36 &quot;</td>
<td></td>
</tr>
<tr>
<td>Brownstone</td>
<td>Portland Conn.</td>
<td>Chilled Slat.</td>
<td>20 &quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>25 &quot;</td>
<td></td>
</tr>
</tbody>
</table>

The above table gives depths of cut only, without regard to its length or the number of same at work.

Those with the * prefixed were made with automatic sand feed.
Conclusion.

The materials employed in engineering can seldom be used without having been first subjected to special mechanical preparations depending on the use to which they are to be applied. It may happen that the cost of the raw or marketable material is very small compared with the expense of shaping and dressing it for use; or, on the other hand, it may be that the quantity used furnishes the chief item to be considered, the work of preparation involving little labor.

In stone masonry the relations between these two items of expense vary greatly; common rubble representing one extreme, and the highly carved elements, or parts of architectural structures the other.
In ordinary engineering works in which stone masonry is employed, this variability in cost depends principally on the amount of work which is expended on the exposed surfaces or faces of the stones, the necessary labor of preparing the beds and joints being to some extent the same for all cases.

The dressing of the exposed faces, however, varies with the object which the masonry is to serve, with the taste of the architect or engineer, or the requirements of architectural design.

In architectural masonry, in which the faces of the stones are not only sometimes highly wrought, but where mouldings, bosses, and carved work form especial features in the design, the work of the stone-cutter becomes
predominant, and a large part of the cost of such stonework is to be found in the cutting.

It is important therefore, that the young engineer and architect should be familiar with the details of an art which plays such an important part in their designs; a necessity which arises chiefly from the difficulty of estimating the cost of any work, unless its technical character can be specified, and the farther difficulty of a proper inspection or supervision, unless the exact quality of the work done can be compared with some standard.