REPORT

—OF THE—

COMMITTEE ON BUILDING STONE

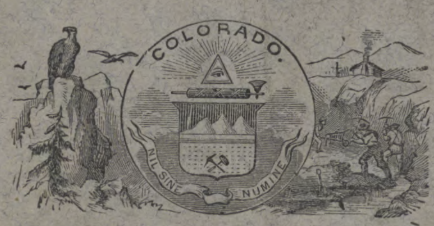
—TO THE—

Board of Capitol Managers

—OF THE—

STATE OF COLORADO.

JULY 3, 1884.



EMBRACING THE REPORT AND TABLES OF THE

DENVER SOCIETY OF CIVIL ENGINEERS

—AND OF—

PROF. REGIS CHAUVENET,

President State School of Mines.

PUBLISHED BY ORDER OF THE BOARD OF CAPITOL MANAGERS.

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DENVER, COLORADO:
TIMES PRINTING COMPANY, STATE PRINTERS.
1884.

REPORT

OF THE

Committee on Building Stone.

DENVER, COLORADO, July 3, 1884.

To the Board of Managers of the Capitol Building:

GENTLEMEN :

Your committee to whom was assigned the work of making an examination and report of the Building Stones of Colorado, specimens of which have been sent to your Board from the quarries within the State, beg leave to submit the Report of the Denver Society of Civil Engineers and of Prof. Regis Chauvenet, President of the State School of Mines.

The former made the mechanical test, including strength, specific gravity and ratio of absorption. The latter made the chemical examination, including the chemical analysis, freezing and ignition tests; also, the ratio of absorption and specific gravity tests, which were made to check those made by the Society of Engineers, all of which will appear in their respective reports.

The samples of stone submitted to the Board embraced two from each quarry; one set being dressed in various forms to show the finish that might be required in the construction of the building. These, which were not to contain less than three cubic feet each, were, after thorough examination by the Board, placed in the National Mining and Industrial Exposition building, where they now are.

The other samples, six inch cubes, were cut up into two inch cubes, two of which were used for determining the crushing resistance. The fragments of the broken cubes and one unbroken cube were sent to the State School of Mines for the tests afterwards made by Prof. Chauvenet. The specimens were all numbered, and the parties making the tests were ignorant of the localities of the quarries, except as to Nos. 10, 11, 50 and 60.

The following table gives the location of the quarries and the corresponding specimen numbers:

No. of Specimen.	Location of Quarry.	Line of Railway.
1.	Brownsville, Clear Creek Co. . . .	Colorado Central.
2.	Pine Creek, Chaffee Co.	D. & R. G.
3.	Platte Canon, Jefferson Co	D. & S. P.
4.	Hancock, Chaffee Co.	" "
6.	Nathrop, Chaffee Co.	D. & R. G.
7.	Calumet, Chaffee Co.	" "
8.	Chaffee City, Chaffee Co.	" "
9.	Calumet, Chaffee Co.	" "
10.	Sanger quarry, Joliet, Illinois . .	Union Pacific.
11.	Rockville quarry, Rockville, Mo. .	A., T. & S. F.
12.	Armejo, Conejos Co.	D. & R. G.
13.	Berthoud, Larimer Co.	Colorado Central.
14.	Goodnight, Pueblo Co.	D. & R. G.
15.	Beaver Creek, Fremont Co.	" "
16.	Oak Creek, " "	" "
17.	Coal Creek, " "	" "
18.	Trinidad, Las Animas Co.	A., T. & S. F.
19.	Brandford, Fremont Co.	D. & R. G.
20.	Feeney, Manitou, El Paso Co. . . .	" "
21.	Tackahoe, Pueblo Co.	" "
22.	Stout, Larimer Co.	Greeley, S. L. & P.
23.	W. H. Case quarry, near Boulder .	Colorado Central.
24.	Morrison, Jefferson Co.	D. & S. P.
25.	" " "	" "
26.	" " "	" "
27.	" " "	" "
28.	" " "	" "
29.	" " "	" "
30.	" " "	" "
31.	" " "	" "
32.	" " "	" "
33.	" " "	" "

34. Unknown. . . . .
35. Dillon, Summit Co. . . . . D. & S. P.
36. El Moro, Las Animas Co. . . . . D. & R. G.
37. Eureka. . . . .
38. Garfield quarry, Douglas Co. . . D. & R. G.
39. Curry quarry, Douglas Co. . . . . " "
40. Unknown. . . . .
41. Morrison, Jefferson Co. . . . . . . D. & S. P.
50. Buckhorn quarry, Larimer Co. . . Colorado Central.
60. Stout quarry, Larimer Co. . . . . Greeley, S. L. & P.

I desire here to acknowledge the valuable assistance given to the Board by Prof. P. H. Van Diest, President of the Denver Society of Civil Engineers, and Prof. Regis Chauvenet, President of the School of Mines, also by Mr. N. W. Sample, Superintendent of motive power of the Denver and Rio Grande Railway shops, for the use of the Company's hydraulic press and gauges. Without the co-operation of the Society and these gentlemen we would have been compelled to send elsewhere for the valuable information contained in this report.

Respectfully,

E. S. NETTLETON,

Committee.

REPORT OF THE COMMITTEE

OF THE

Denver Society of Civil Engineers.

DENVER, COLORADO, July 3, 1884.

To the Committee of the Colorado Board of Capitol Managers:

GENTLEMEN:

Before submitting to your consideration the results of the different tests made on the samples of building stone entrusted to us for experiment and determinations, it appears necessary, for the better understanding of the evidence of our observations, to give a general idea of the character and properties of different building stones and of the influences which affect their durability.

Solidity and durability are the most essential properties of a good building stone. The ancients taught us to pay scrupulous attention to the choice of building material. Despite their poor facilities for transportation, distance was not considered by them a sufficient reason for rejecting those stones which were recognized as capable of withstanding the effects of time. In ancient edifices and monuments which still exist, such as the monument of Carnac, in France; the famous Stone Henge, in England; the Booroo Boodor, in Java, and others elsewhere, durability was the main object sought for. Architecture and decoration require, however, still other properties. Not only are those stones rejected which crumble by exposure or crack by frost, but a fine and uniform grain is desirable; the stones must be easily cut, resist the blow of the hammer and endure heat without cracking; in short, they should possess all the properties requisite to give to buildings a permanent solidity and a pleasing and imposing aspect.

Limestones, granites, sandstones and lavas are the principal stones used in architecture. A great variety of these stones exist in localities easily accessible from Denver.

Limestone effervesces with acids, changes into quicklime by calcination, and is readily cut and polished. These last named properties, together with the fact that limestone occurs generally in thick layers, easily separated, have always brought it into great demand.

Most of the principal buildings in Paris, Marseilles and Lyons are constructed of this material.

Limestone does not resist the destructive action of rain, frost and great heat as well as granite, lavas and many sandstones.

When quarried, it is generally softer than after exposure to air for some time. This is due to the moisture which it contains in the quarry and which it loses only on long exposure. It should, therefore, not be dressed for building purposes until it has lost this moisture or quarry water; otherwise it is liable to crack by frost. Many limestones contain fossils; this does not affect the cohesion of the mass, but causes the color to change soon to a sombre grey on account of the many cavities, which allow the accumulation of dust and the growth of lichens.

Granite, well dressed and especially when polished, is unquestionably the most durable, the brightest colored and the nearest perfect of all building stones. It is composed of quartz, feldspar and mica, firmly aggregated and simultaneously crystalized. The fine grained varieties are extremely hard and indestructible, and can receive a very high polish. Not being stratified, granite is quarried with difficulty, and on account of its hardness is very expensive to cut and dress. Rondelet, a French architect, who has made a special study of building material, estimates that granite is ten times harder to saw than limestone.

The principal buildings and the fortresses of Rio Janeiro are built of a grey granite.

Of the different products of volcanos two kinds can be used for building purposes, the semi-porous (not scorified) lava and the volcanic tufa. These have generally a low specific gravity and are on that account desirable for arches, vaults, etc.

Basalt, a variety of compact lava, is too hard to be cut and dressed. The semi-porous lavas are more easily worked, and both on account of their composition (which is analogous with puzzolano and hydraulic cements), and their numerous cavities, they unite firmly and form a solid structure with mortar. Lavas are very useful in irregular or partly dressed blocks to serve as foundations.

Tufa is a volcanic ash or sand, firmly held together by an argillaceous, calcareous or ferruginous cement. It occurs generally in layers or beds, and is readily quarried. It is extensively used in Italy.

Sandstone consists of grains of sand held together by some cement. It occurs in layers or strata of varying thickness and hardness. It is sometimes coarse and sometimes fine grained and is easily quarried. It is dressed with little expense, though not so readily as limestone, and cannot be polished. Dark-colored limestones are found to be generally harder than the light-colored ones, but the reverse is true of sandstones. The light-colored sandstones possess generally the greatest hardness and solidity, have fewer cracks and fissures, and are finer grained and less friable than the red and brown sandstones. Sandstone is the principal building stone of Germany and Spain.

The testing of building stones is naturally divided in experiments on their solidity and on their durability.

To ascertain the solidity of a stone the weight per cubic foot must be known, and its strength, or in other words, the resistance it can oppose to crushing pressure.

General Q. A. Gillmore found that the crushing force required for granites was 8,000 to 24,000 pounds per square inch, for good limestones 3,000 to 20,000 pounds per square inch, for superior sandstones 4,000 to 12,000 pounds per square inch.

Rondelet gives similar figures for good building material in Europe. For basalt he found the compressive strength 30,000 pounds per square inch; for prime brick 1,000 to 1,800 pounds; common brick 500 to 600 pounds, and good mortar 400 pounds.

Doctor Brix tested a great many building stones for the cathedral in Cologne, also several sandstones used for buildings in Berlin. Amongst other stones he found that a tufa of the Brahl valley crushed under a weight of 750 pounds per square inch. A trachyte of the Drachenfels withstood a pressure of 2,750 pounds; sandstone of Rothenberg, 2,380 pounds; from Seehausen, 1,430 pounds; from Woenslebe, 1,200 pounds per square inch. These sandstones are all used for building in Berlin.

Looking over the annexed Exhibit A, it will be observed that all the Colorado sandstones tested by us are, in this respect, superior to those from the above named places. It must be remarked that some of the stones tested by Brix resisted a greater pressure for some time, but after being kept under the same pressure for several days began to show cracks. It is thus wise to select stones which can withstand, without crushing, from eight to ten times the total pressure they are required to support in the buildings in which they are used.

Rondelet gives examples of great weights supported by the building stones in certain prominent structures. The columns of St. Peter, in Rome, support a weight of 224 pounds per square inch; those of St. Paul, in London, 280 pounds, and those of the Pantheon, in Paris, 426 pounds.

The durability of building stone depends on the degree of resistance it can oppose to the influences of temperature, air and moisture. The destructive action of these influences is called the "weathering." The weather acts both physically and chemically, the former by rain and frost, the latter by the solvent action of atmospheric water and the oxidizing action of the oxygen of the atmosphere.

By these actions the stone loses its component parts, changing its consistence, form and color.

Weathering begins at the surface and goes sometimes quite deep, aided by small fissures and cracks in the stones. Its first stage can be often recognized by change of color or bleaching. Limestones and many sandstones, colored dark by carbon and bitumen, bleach because the carbon matter slowly disappears in the form of carbondioxide. This carbonic acid accelerates the dissolution of the building stone. Hence organic matter is an objectionable constituent of building stone. Stones containing hydrated ferric oxide and ferrous oxide, the first giving a yellowish color, and the other a more bluish or greenish color to the stones, turn, by the effect of the oxygen, evenly or in spots to a dirty red color. The action of the oxygen of the atmosphere is only destructive to those stones which contain ferrous oxide or organic matter. The property of some compounds to absorb nitrogen and carbonic acid from the atmosphere, changing their chemical stability, is destructive to those stones which contain these compounds. Magnesian carbonate has this property to a higher degree than calcium carbonate, and hydrated ferric oxide still greater. Therefore limestones containing much magnesia are less durable than pure calcareous limestones, and of stones which contain hydrated ferric oxide a more or less speedy disintegration must be expected.

Granites, syenites and other feldspathic stones are subject to disintegration by the chemical decomposition of the feldspar; it is principally the orthoclase feldspar, which changes into kaolin by the action of the rain water and the carbonic acid dissolved therein.

Some granites are more subject to this disintegrating process than others; some weathering rapidly, while others resist the action of the atmosphere and water for ages. In general the fine grained granites, in which the particles of quartz and feldspar are evenly divided and dispersed are the best for building purposes. When quartz is in excess the granites are too hard to be dressed; when feldspar is in excess, and in large crystals, speedy disintegration is to be feared; and when mica is in excess the stone has a tendency to exfoliate. The proportion and the size of the component parts are seldom constant over a great extent in granite beds. This limits the quarrying and makes it often difficult to produce great quantities of building stones of exactly the same quality and color. The best guides to selecting good stones in a granite region are furnished by nature herself in the big boulders cliffs, which indicate the kind of composition of its constituents that withstood the effects of atmosphere and erosion the best.

The physical action of water on stones is one of wearing. The rainwater softens many a sandstone, and wind hurling rain drops against the sides, particles are loosened and crumble off. If the stone, when wet, is exposed to a temperature below freezing point, the expansion of the freezing water will wedge the particles of the stone apart.

Thus, the greater the amount of moisture absorbed by a stone, and the smaller the pores of the same, the greater will be the disintegrating effect of frost on the stone. Some stratified rocks contain a considerable amount of clay, and this substance absorbing more or less moisture than the other constituents, exfoliation by frost will follow. Clay is therefore a dangerous ingredient of building material.

Forty specimens of building stones were tested; with two exceptions they are all from quarries in Colorado. The exceptions are No. 10, the well-known Joliet stone, and No. 11, from Rockville, Mo., both excellent building stones.

These stones were subjected to all the different tests, together with the other specimens, because the comparison of the results of the tests made by us with the results of experiments on these stones made elsewhere, gave a fair criterion of the degree of accuracy of the tests made on the Colorado stones.

It may be here mentioned that the results of our tests on these stones agree very well indeed with the results obtained by Gen. Q. A. Gilmore, W. P. Butler and Gustave Hinricks.

The specific gravity and the rate of absorption of all the stones was determined.

The relative resistance to the action of frost and the loss by ignition was determined of all, except numbers 21, 29, 30, 31 and 41.

All except the four specimens of granite were chemically analyzed.

Experiments on the compressive strength were made on all, except Nos. 50 and 60. These specimens were sent in long after the crushing tests took place.

The crushing tests were made with the hydraulic press in the Rio Grande shops. The result of these experiments is given in Exhibit A.

The specimens used for that purpose were all made of an uniform size of 2-inch cubes. As a medium for communicating the pressure, disks of soft pine wood were used.

The mode of testing the stones on their resistance to the action of frost is described in the annexed report of Prof. Regis Chauvenet, of the State School of Mines, who made elaborate and careful analyses of most of the forty samples of building stones.

Prof. J. A. Sewall, of the State University, made also analyses of several specimens. The result of his analyses of stones, not analyzed by Prof. Chauvenet are given in Exhibit B.

To facilitate comparison of the different specimens in regard to their relative degree of excellence, Exhibit C is prepared.

In the column "Strength" is indicated a resistance to crushing pressure from—

15,000—20,000	lbs. per	square	inch	with	I.
10,000—15,000	"	"	"	"	II.
5,000—10,000	"	"	"	"	III.
3,000— 5,000	"	"	"	"	IV.
0— 3,000	"	"	"	"	V.

In the column "Absorbs" is indicated the ratio of absorption.

From 0 — $2\frac{1}{2}$	per cent	with	. . .	I.
" $2\frac{1}{2}$— 5	"	"	"	. . . II.
" 5 — $7\frac{1}{2}$	"	"	"	. . . III.
" $7\frac{1}{2}$—10	"	"	"	. . . IV.

In the column "Freezing" is indicated the degree of disintegration by freezing.

From 0 —0.05	per cent	with	. . I.
" 0.05—0.1	"	"	" . . II.
" 0.1 —0.5	"	"	" . . III.
" 0.5 —1	"	"	" . . IV.

In the column "Ignition" is indicated the loss by exposing the stones to heat, giving loss as carbonic acid and water.

From 0. —1.00	per cent.,	with I.
" 1. —2.5	"	" II.
" 2.5 —5	"	" III.
" 5.00—8.00	"	" IV.

For sandstones, is in the column "Alkalies" indicated the amount of potassa and soda.

From 0.— 2	per cent,	with I.
" 2.— 5	"	" II.
" 5.— 7	"	" III.
" 7.—10	"	" IV.

For sandstones is also indicated in the column "Iron Oxides," the amount of hydrated ferric and ferrous oxide:

From 0 —1	per cent.,	with I.
" 1 —$2\frac{1}{2}$	"	" II.
" $2\frac{1}{2}$—5	"	" III.
Over 5	"	" IV.

The stones which resist the greatest pressure, are the least subject to the action of frost, absorb the least amount of water, are in that way indicated with the lowest figures in each column.

The stones having the lowest aggregate of all the figures in the different columns will thus, in a measure, have a superiority over stones indicated with a greater aggregate. This gives only an approximate method of comparing. Color, grain, etc., have influence on the selection of stones for building purposes, all other qualities being equal.

From all evidence before us, we summarize the classification of the Colorado building stones under consideration, in their order of excellence, as follows:

Limestones—

First, No. 7.
Second, No. 9.

Granites—

First, No. 1.
Second, Nos. 3, 2, 4.

Sandstones—

First, Nos. 23, 35.
Second, Nos. 22, 34, 24, 50, 29, 28, 60.
Third, Nos. 18, 12, 15, 40, 32, 36, 26.
Fourth, Nos. 27, 37, 13, 25, 17, 19, 20, 16, 14.

Lavas—

Nos. 6, 38, 39.

We cannot end this report without making two suggestions. In the first place we would recommend a visit to the quarries whence the specimens came, which attract the most attention for their excellence, in order to ascertain if the bed from which these specimens were taken has sufficient extent to produce all the stone necessary for a structure of so vast dimensions as the capitol building will have.

Often it happens that stones coming out of the same quarry have different properties in regard to weathering. The color may also differ considerably at different parts of the quarry.

A thorough study of the outcrops and of pieces which have been exposed to the influence of rain, snow and frost during many seasons, is essential.

Second, we would recommend when a selection is made, that the stone blocks be quarried long before they are dressed and placed in the building. Lime and sandstones require seasoning as well as lumber.

When these stones, principally those having small pores, are dressed before they are slowly freed of their quarry water in the shade, and are thus exposed to the hot sun, the moisture in the stone will suddenly expand and cause the stone to shale off and form fine cracks near the surface.

Frost will have the same disintegrating effect on otherwise excellent and durable stones. When stones are once thoroughly dry, the best means of preservation is to prevent the intrusion of water by closing the pores on the exposed surface.

The pores of granites and limestones can be best closed by giving these stones a polish. Sandstones will be preserved and can be polished when their surfaces are treated with a solution, filling the pores with a silicate of alumina, as for instance is done in the quarries of Saxonia, in Neundorf, near Pirna.

Such preservatives not only prevent moisture entering the stone, but prevent dust settling in the pores and also the formation of lichens, which not only give an ugly appearance to the stone but accelerate the disintegration.

DENVER SOCIETY OF CIVIL ENGINEERS,

By P. H. VAN DIEST,
E. S. NETTLETON,
JOHN PIERCE,
ROBT. B. STANTON,
J. A. SEWALL,
Committee.

EXHIBIT A.

No. of Specimen.	DESCRIPTION.	Dimensions of Specimen, Inches.	Position Given by Crushing Test.	Strength of Specimen.	Strength Per Square Inch.	Specific Gravity.	Weight of One Cubic Foot Stone, Pounds.	Ratio of Absorption, Per Cent.	REMARKS.
				GRANITES.					
1	Grey color, very fine and evenly divided, particles of black mica, glossy feldspar	2x1 94	. . . .	74,146	19,110	2.71	168.48	0.17	Broke suddenly in wedges.
2	Mica as in No. 1, but more feldspar, not so evenly divided	2x2	. . . .	56,558	14,137	2.67	164.74	0.31	Broke in small wedges.
3	Flesh colored, coarse grain	2x1.98	. . . .	65,345	16,501	2.65	164.11	0.19	Broke suddenly, middle part powdering.
4	Grey, feldspar in excess, mica coarser than in 1 and 2	2x2	. . . .	47,752	11,938	2.71	167.86	0.26	Powdered.
				LIMESTONES.					
7	Dolomite, banded, blue streaks on white; very compact; fine grain	2x2	Bed.	62,832	15.708	2.87	179.09	0.07	Crushed at once to plates.
9	Marble, color white, slightly seamed	2x1.97	Bed.	54,035	13,715	2.86	177.84	0 09	Idem.
10	Joliet limestone, Ills., color dull grey; fine grain	2x2	Bed.	63,083	15,771	2.75	165.36	1.36	Crushed at once.
"	. . . .	2x1.98	Edge.	54,789	13,836	.	. . . .	. . .	Flakes sprung off first, then crushed to pieces.
				SANDSTONES.					
11	Rockville, Mo., grey	2x1.97	Bed.	23,875	6,' 60	2.53	137.28	5.77	Cracked first, then crushed to powder.
12	Grey, with yellow tinge	2x2	Bed.	31,164	7.420	2.50	139.77	4.42	Broke in three wedge shaped pieces.
"	. . . .	2.05x2.05	Edge.	24,630	6,157	. .	. . . .	.	Idem.
13	Light red	2.08x2.08	Edge.	29,656	6,849	2.49	139.77	4.44	Broke in teeth form.
14	Porous, friable, yellowish white	2.03x2.03	. . . .	Did hardly raise needle of guage.		2.39	127.92	6.94	Broke suddenly before reading was possible, soft stone.
15	Light grey, firm texture, fine grain, shows specks of iron oxide	2x2	Bed.	21,614	5,403	2.45	134.78	5.28	Crushed to very small pieces.
"	. . . .	2x2	Edge.	18,598	4,649	. .	. . . .	. . .	Idem.
16	Yellow, fine grain	1.96x1.96	Bed.	11,058	2,900	2.41	119.81	9.69	Broke in teeth.
"	. . . .	2x2	Edge.	10,555	2,639	. .	. . . .	. . .	Idem.
17	Yellowish grey, inclining to brown	1 96x1.96	Edge.	12,063	3,141	2.44	130.42	6.05	
18	Pure light grey, fine grain	1 96x1.96	Bed.	39,710	10,337	2.64	181.01	3.12	Clean break in few wedge shaped pieces.
"	. . . .	1.98x1.98	Edge.	35,186	8,975	. .	. . . .	. . .	Idem.

EXHIBIT A.—*Continued.*

No. of Specimen.	DESCRIPTION.	Dimensions of Specimen, Inches.	Position Given by Crushing Test.	Strength of Specimen.	Strength Per Square Inch.	Specific Gravity.	Weight of One Cubic Foot Stone, Pounds.	Ratio of Absorption, Per Cent.	REMARKS.
	SANDSTONES.—Continued.								
19	Brown, fine grain	2.07x1.97	Bed.	17,593	4,333	2.49	126.05	8.99	
"	. . . .	2x2.03	Edge.	17,090	4,300	. .	. . . .	. . .	
20	Dull white, fine in grain	2.02x2.02	Bed.	13,069	3,204	2.51	134.16	6.46	Broke off on one side, probably by uneven pressure.
"	. . . .	1,98x1.98	Edge.	16,085	4,093	. .	. . . .	. . .	Clean break.
21	White, coarse grain	2x2	Bed.	14,577	3,644	2.43	126.41	6.33	Crushed to fine sand.
22	White, fine grain	1.98x1.98	Bed.	50,768	12,916	2.56	153.50	1.54	Broke very suddenly to pieces.
"	. . . .	1.98x1.98	Edge.	55,794	14,197	. .	. . . .	. . .	Idem.
23	Light pink, firm, very compact in structure	1.99x1.99	Bed.	66,601	16,818	2.49	151.01	1.13	Idem.
"	. . . .	1.98x1.98	Edge.	47,752	12,180	. .	. . . .	. . .	Idem.
24	Fine grain, porous	2.07x2.07	Bed.	30,763	7,179	2.47	134.16	6.00	Average of two tests.
25	Light red	2.07x2.07	Bed.	27,646	6,452	2.48	138.53	4.64	Much smashed and powdered.
"	. . . .	2x2	Edge.	21,363	5,341	. .	. . . .	. . .	Idem.
26	Dark red, very compact	2.03x2.03	Bed.	50,266	12,198	2.61	158.50	0.77	
"	. . . .	2.01x2.01	Edge.	45,239	11,198	. .	. . . .	. . .	Not very good test.
27	Red, coarse granules of quartz inclosed	2.07x2.07	Bed.	40,212	9,385	2.64	160.37	0.85	Broke in many teeth formed pieces.
"	. . . .	2.11x1.95	Edge.	40,966	9,957	. .	. . . .	. . .	Idem.
28	Pinkish white, very friable	2.06x2.06	Bed.	31,416	7,403	2.41	135.41	4.64	Powdered.
29	Mottled grey, streaks of blackish clay	1.98x2.06	Bed.	37,699	9,616	2.51	142.31	2.42	Smashed to pieces.
"	. . . .	1.98x2.06	Edge.	33,929	8,318	. .	. . . .	. . .	Idem.
30	Grey mottled, clayey	2.03x2.03	Bed.	27,646	6,709	2.40	135.58	5.31	
31	Fine mottled hone	1.98x1.98	Bed.	27.640	7,052	2.47	137.32	3.90	
"	. . . .	2x2	Edge.	27,646	6,911	. .	. . . .	. . .	
32	Dull white	2.01x2.01	Bed.	20,106	4,976	2.50	135.41	6.95	Crushed to fine sand.
"	. . . .	2.02x2.02	Edge.	23,876	5,852	. .	. . . .	. . .	Not so badly pulverized.
34	Pinkish tinge, fine grain	2.03x2.03	Bed.	60,821	14,762	2.54	150.38	1.99	Sprung to pieces with a loud report.
"	. . . .	2.05x2.05	Edge.	55,292	13,164	. .	. . . .	. . .	
35	Mottled with spots of a yellow and a dark mineral	2.01x2.01	Bed.	52,779	13,064	2.50	150.38	1.52	
"	. . . .	2.01x2.01	Edge.	47,752	11,819	. .	. . . .	. . .	
36	Light grey, porous	2x2	Bed.	17,341	4,335	2.46	132.29	5.89	
"	. . . .	1.98x1.98	Edge.	13,069	3,334	. .	. . . .	. . .	

EXHIBIT A.—*Continued.*

No. of Specimen.	DESCRIPTION.	Dimensions of Specimen, Inches.	Position Given by Crushing Test.	Strength of Specimen.	Strength Per Square Inch.	Specific Gravity.	Weight of One Cubic Foot Stone, Pounds.	Ratio of Absorption, Per Cent.	REMARKS.
				SANDSTONES.—Continued.					
37	Yellowish white, friable	2.02x2.02	Bed.	16,587	4,065	2.40	127.30	7.03	
40	Light brownish red, firm	2.02x2.02	Bed.	42,725	10,476	2.46	136.66	4.89	Clear break.
41	Red, conglomerate of little quartz pebbles and iron oxide cement	2x2	Bed.	17,090	4,272	2.67	149.85	1.35	
"	. . . .	2x2	Edge.	15,582	3,895	. .	. . . . .	. .	
				LAVAS.					
6	Ash grey	2x2	. . . .	29,656	7,414	2.45	141,65	3.18	Cracked before crushing.
38	Pink color	2x2	1st	32,416	8,104	2.14	109.20	9 76	
"	. . . .	2.02x2.02	2d	33,929	8,316	. .	. . . . .	. .	
39	Grey color	2.03x2.63	1st	43,983	10,675	2.23	119.18	7.36	
"	. . . .	1.98x1 98	2d	46,244	11,800	. .	. . . . .	. . .	
				Test Made on Cement.					
	Colorado Clear Cement (Denver Works) . . .	. . . . .	. . . .	15,079	4,245	. .	. . . . .	. . .	

Exhibit B.

No. 21.

Silica	85.4
Ferric oxide	trace
Alumina	14.56
	99.96

No. 29.

Silica	82.00
Alumina	17.70
	99.70

No. 30.

Silica	93.00
Alumina	6.28
	99.28

No. 31.

Silica	82.00
Alumina	17.73
	99.73

No. 41.

Silica	84.30
Ferric oxide	4.70
Alumina	10.90
	98.90

No. 16.

Ferric oxide . . . . 4.46 per cent.

No. 17.

Ferrous oxide . . . . 2.47 per cent.

No. 18.

Ferrous oxide . . . . 2.35 per cent.

No. 19.

Ferrous oxide . . . . 3.54 per cent.

No. 25.

Ferric oxide . . . . 3.18 per cent.

No. 36.

Ferrous oxide 2.88

No. 40.

Ferric oxide 1.31

Exhibit C.

No. of Sample.	Strength.	Absorbs.	Freezing.	Ignition.	Alkalies.	Iron Oxides.	Aggregate.
			GRANITES.				
1	I.	I.	I.	. . . . .	. . . . .	. . . . .	. . . .
2	II.	I.	I.	. . . . .	. . . . .	. . . . .	. . . .
3	I.	I.	I.	. . . . .	. . . . .	. . . . .	. . . .
4	II.	I.	I.	. . . . .	. . . . .	. . . . .	. . . .
			LIMESTONES.				
7	I.	I.	I.	I.	. . . . .	. . . . .	. . . .
9	II.	I.	I.	I.	. . . . .	. . . . .	. . . .
			SANDSTONES.				
12	III.	II.	III.	II.	II.	II.	14
13	III.	II.	III.	IV.	II.	II.	16
14	V.	III.	III.	II.	I.	I.	16
15	IV.	III.	II.	II.	I.	III.	15
16	IV.	IV.	IV.	II.	II.	III.	19
17	IV.	III.	IV.	III.	I.	II.	17
18	II.	II.	III.	III.	II.	II.	14
19	IV.	IV.	III.	II.	III.	III.	19
20	IV.	III.	III.	III.	II.	II.	17
22	II.	I.	I.	III.	II.	I.	10
23	I.	I.	I.	I.	I.	II.	7
24	III.	III.	I	I.	I.	I.	10
25	III.	II.	III.	IV.	I.	II.	15
26	II.	I.	III.	III.	II.	III.	14
27	II.	I.	III.	III.	II.	III.	14
28	III.	II.	II.	I.	I.	I.	10
29	III.	II.	III*.	II*.	I.	I.	12
32	III.	III.	III.	II.	II.	I.	14
34	II.	I.	III.	II.	I.	I.	10
35	II.	I.	I.	I.	I.	I.	7
36	IV.	III.	III.	II.	II.	II.	16
37	IV.	IV.	III.	II.	I.	I.	15
40	II.	II.	III.	II.	I.	II.	12
50	III*.	II.	I.	I.	I.	II.	10
60	III*.	I.	I.	II.	I.	I.	9
			LAVAS.				
6	III.	II.	I.	I.	. . . . .	. . . . .	. . . .
38	III.	IV.	III.	I.	. . . . .	. . . . .	. . . .
39	II.	IV.	III.	II.	. . . . .	. . . . .	. . . .
Joliet stone, Ills.	I.	I.	II.	I.	I.	I.	7
Rockville stone, Mo.	III.	III.	III.	II.	II.	I.	14

*Approximative.

GOLDEN, COLORADO, June 23, 1884.

To the Committee of the Board of Capitol Managers,

GENTLEMEN:

I present herewith analyses and other tests of samples of building stones, forwarded to me by Mr. P. H. Van Diest.

In tabulating the results, the samples are designated simply by the numbers, as, with two exceptions, I know nothing of their respective localities. The exceptions are Nos. 50 and 60, being samples sent by the Union Pacific Railroad Company at the same time as the ones sent by your body. Their localities are given in the tables.

In making the specific gravity tests, pieces of uniform size (2 by 1 by ½ inch) were taken, and, after weighing, were allowed to soak in pure water for some hours before being weighed in water. The results are given in the tables as "Sp. gr."

After this determination, each piece was weighed in air, the surfaces having been wiped dry. The gain in weight indicates the relative porosity, and is given under head "Absorbs," the figures showing the per centage of its own weight which each stone can absorb of water.

By substracting from the weight of the stone *when saturated with water*, its weight *in water*, we obtain the weight of water equal in bulk to the stone, *considered as a geometric solid only*. It differs from the remainder obtained in determination of "Sp. gr." proper, by the weight of the water contained in the pores of the stone. Dividing the weight of the dry stone by this remainder, we obtain a figure which I designate as "Apparent Sp. gr.," and which indicates the relative weight of a mass of the stone to an equal volume of water. By multiplying "Apparent Sp. gr." by the weight of one cubic foot of water, the weight of one cubic foot of the stone is obtained. This computation has been made for each stone, and the results will be found in place with the other data.

In order to test the effect of frost, a special apparatus was constructed, consisting of a shallow pan with overlapping lid, in which the samples were placed, each one having been thoroughly saturated with water. This pan was supported in the center of a large box, capable of holding two hundred pounds of ice, and provided with a stop-cock for drainage. A mixture of ice and salt was packed closely about the pan, and a temperature below freezing was maintained in one experiment for twenty-four hours, in a second one for over forty-eight hours. None of the samples broke under this test, though they were all frozen to the pan in each experiment. Being thawed, dried, and re-weighed, each was found to have suffered a loss in weight, whose per centage is given under the head "Loss by Freezing." The short time occupied hardly enables us to draw any conclusions as to the probable effect of "weathering," nevertheless, the variations are seen to be great, running from a few thousandths of one per cent. up to seven-tenths of one per cent.

In making the analyses, alumina and oxide of iron were not separated, except in a single instance. When one of these only is named, it indicates a very great preponderance of the same, but not to the entire exclusion of the other. When both are named, the one placed first is the largest in amount.

Although it is hardly within the scope of this report to recommend or condemn any special sample, I may say that a stone with a high "absorption" figure should be regarded with suspicion. Whether alkalies are injurious to the durability of a sandstone depends largely upon their state of combination, and no experiments upon this point were made.

Generally, marble, dolomite and compact limestones are more durable even than granite, while sandstones must in this respect take a lower place on the list. Lavas are more durable as they approach a slagged condition.

My thanks are due to Dr. Geo. S. Mackenzie, Instructor in Chemistry at the State School of Mines, for a vast amount of careful and accurate work on the analytical portion of the investigation. A majority of the deter-

minations, exclusive of the alkalies, are from his hands.

Much assistance was also rendered by Mr. Chas A. Gehrmann, student in Quantitative Analysis at the School, whose work (chiefly on the Alkalies) was under the supervision of Prof. M. Moss. To the latter gentleman I am also indebted for the details of the freezing device, and for aid in calculating and revising the results.

With the hope that the present report may assist the Commission in the selection of a suitable material for the Capitol building, I remain,

Respectfully yours,

REGIS CHAUVENET.

ANALYSES.

To facilitate comparison the respective localities are placed behind the numbers.

No. 1.—Grey Granite. Brownsville, Clear Creek County. Not analysed.

Sp. Gr., ... 2.71 Apparent Sp. Gr , 2.70
Absorbs . . . . 0.17 per ct. Cu. foot weighs 168.48 lbs.
Loss by freezing, . . . 0.009 per cent.

No. 2.—Grey Granite. Pine Creek, Chaffee County. Not analysed.

Sp. Gr., ... 2.67 Apparent Sp. Gr., 2.64
Absorbs . . . . 0.31 per ct. Cu. foot weighs 164.74 lbs.
Loss by freezing, . . . 0.056 per cent.

No. 3—Red Granite. Platte Canon, Jefferson County. Not analysed.

Sp. Gr., ... 2.65 Apparent Sp. Gr., 2.63
Absorbs . . . . 0.19 per ct. Cu. foot weighs 164.11 lbs.
Loss by freezing, . . . 0.033 per cent.

No. 4.—Grey Granite. Hancock, Chaffee County. Not analysed.

Sp. Gr., ... 2.71 Apparent Sp. Gr., 2.69
Absorbs . . . . 0.26 per ct. Cu. foot weighs 167.86 lbs.
Loss by freezing, . . . 0.023 per cent.

No. 6.—Lava. Nathrop, Chaffee County. Color, ash grey; shows many small cavities not affecting its general appearance.

Silica	76.56		
Alumina & Ox. Iron	14.25	Sp. Gr.	2.45
Lime	1.17	Apparent Sp. Gr.	2.27
Magnesia	0.42	Absorbs	3.18 p. ct
Potassa	3.78	Cubic ft. weighs	141.65 lbs.
Soda	3.93	Loss by freezing	0.034 p. ct
	100.11		

No. 7.—Dolomite, Calumet, Chaffee County. Banded, blue streaks on white. Very compact and fine in grain.

Silica	0.66	Sp. Gr.	2.87
Ox. Iron	0.41	Apparent Sp. Gr.	2.87
Lime	31.02	Absorbs	0.07 p. ct
Magnesia	21.04	Cubic ft weighs	179.09 lbs.
Carbonic Acid	46.90	Loss by freezing	0.004 p. ct
	100.03		

No. 9.—Marble, Calumet, Chaffee County. Color, white; slightly seamed.

Silica	1.57	Sp. Gr.	2.86
Alumina	0.57	Apparent Sp. Gr.	2.85
Lime	33.85	Absorbs	0.09 p. ct
Magnesia	17.88	Cubic ft. weighs	177.84 lbs.
Carbonic Acid	45.96	Loss by freezing	0.022 p. ct
	99.83		

No. 10.—Limestone, Sanger Quarry, Joliet, Illinois. Fine in grain, but showing small cavities. Color, dull grey.

Silica	15.25		
Alumina	4.68	Sp. Gr.	2.75
Ox. Iron	1.00	Apparent Sp. Gr.	2.65
Lime	25.63	Absorbs	1.36 p. ct
Magnesia	14.42	Cubic ft. weighs	165.36 lbs.
Carbonic Acid	38.90	Loss by freezing	0.065 p. ct
	99.88		

No. 11.—Sandstone, Rochville Quarry, Rochville, Mo. Grey, with yellow tinge. Fine grain.

Silica	82.07		
Alumina & Ox. Iron	11.10		
Lime	0.98	Sp. gr.	2.53
Magnesia	0.81	Apparent sp. gr.	2.20
Potassa	1.29	Absorbs	5.77 p. ct
Soda	1.06	Cubic ft. weighs	137.28 lbs.
Loss by ignition . . .	2.48	Loss by freezing	0.229 p. ct
	99.79		

No. 12.—Sandstone, Armejo, Conejos County. Grey, similar in grain to No. 11.

Silica	81.01		
Alumina & Ox. Iron	13.02		
Lime	0.65	Sp. Gr.	2.50
Magnesia.	0.56	Apparent Sp. Gr.	2.24
Potassa	1.71	Absorbs	4.42 p. ct
Soda	1.59	Cubic ft. weighs	139.77 lbs.
Loss by ignition . . .	1.62	Loss by freezing	0.243 p. ct
	100.16		

No. 13.—Sandstone, Berthoud, Larimer County. Color, light red. Effervesces with acids. Very similar to No. 25.

Silica	74.86		
Ox. Iron	4.05	Sp. Gr.	2.49
Lime	10.25	Apparent Sp. Gr.	2.24
Magnesia	1.10	Absorbs	4.44 p. ct
Loss by ignition . . .	7.90	Cubic ft weighs	139.77 lbs.
Alkalies, undetermined		Loss by freezing	0.110 p. ct
	98.16		

No. 14.—Sandstone, Goodnight, Pueblo County. Porous, and very friable. Yellowish white in color. Very similar to No. 37.

Silica	89.94	Sp. Gr.	2.39
Alumina & Ox. Iron	5.62	Apparent Sp. Gr.	2.05
Lime	1.95	Absorbs	6.94 p. ct
Magnesia	0.19	Cubic ft. weighs	127.92 lbs.
Loss by ignition	2.46	Loss by freezing	0.166 p. ct
	100.16		

No. 15.—Sandstone, Beaver Creek, Fremont County. Color, light grey. Firm texture, fine grain. Shows fine specks of oxide of iron.

Silica	92.92	Sp. Gr.	2.45
Ox. Iron	4.61	Apparent Sp. Gr.	2.16
Lime	0.90	Absorbs	5.28 p. ct
Magnesia	0.23	Cubic ft. weighs	134.78 lbs.
Loss by ignition	1.41	Loss by freezing	0.062 p. ct
	100.07		

No. 16.—Sandstone, Oak Creek, Fremont County. Yellow color, fine grain.

Silica	76.02		
Alumina & Ox. Iron	16.42		
Lime	2.10	Sp. Gr.	2.41
Magnesia	0.88	Apparent Sp. Gr.	1.92
Potassa	2.24	Absorbs	9.69 p. ct
Soda	1.04	Cubic ft. weighs	119.81 lbs.
Loss by ignition	1.15	Loss by freezing	0.700 p. ct
	99.85		

No. 17.—Sandstone, Coal Creek, Fremont County. Yellow-grey, inclining to brown.

Silica	74.20		
Alumina & Ox. Iron	17.02		
Lime	2.68	Sp. Gr.	2.44
Magnesia	1.23	Apparent Sp. Gr.	2.09
Potassa	1.04	Absorbs	6.05 p. ct
Soda	0 65	Cubic ft. weighs	130.42 lbs.
Loss by ignition	2.81	Loss by freezing	0.649 p. ct
	99.63		

No. 18.—Sandstone, Trinidad, Las Animas County. Pure light grey, fine grain.

Silica	71.00		
Alumina & Ox. Iron	19.39		
Lime	0.98	Sp. Gr.	2.64
Magnesia	0.19	Apparent Sp. Gr.	2.42
Potassa	1.64	Absorbs	3.12 p. ct
Soda	3.80	Cubic ft. weighs	151.01 lbs.
Loss by ignition	2.87	Loss by freezing	0.324 p. ct
	99.87		

No. 19.—Sandstone, Brandford, Fremont County. Brown color, probably quite alkaline.

Silica	75.77		
Alumina & Ox. Iron	14.57	Sp. Gr.	2.49
Lime	0 95	Apparent Sp. Gr.	2.02
Magnesia	0.49	Absorbs	8.99 p.ct
Loss by ignition	1.68	Cubic ft. weighs	126.05 lbs.
Alkalies, not determined.		Loss by freezing	0.322 p.ct
	93.46		

No. 20.—Sandstone, Feeney, Manitou, El Paso County. Dull white, fine in grain.

Silica	70.75		
Alumina & Ox. Iron	17.68		
Lime	1.15	Sp. Gr.	2.51
Magnesia	0.76	Apparent Sp. Gr.	2.15
Potassa	2.25	Absorbs	6.46 p. ct
Soda	3.67	Cubic ft. weighs	134.16 lbs.
Loss by ignition	3.34	Loss by freezing	0.190 p. ct
	99.60		

No. 22.—Sandstone, Stout, Larimer County. Effervesces with acids, fine grain. Color pinkish-grey.

Silica	84.07		
Alumina & Ox. Iron	2.95		
Lime	4.36	Sp. Gr.	2.56
Magnesia	0.91	Apparent Sp. Gr.	2.46
Potassa	1.24	Absorbs	1.54 p. ct.
Soda	2.32	Cubic ft. weighs	153.50 lbs.
Loss by ignition	4.21	Loss by freezing	0.050 p. ct
	100.06		

No. 23.—Sandstone, W. H. Case Quarry, near Boulder. Light pink, firm, works to fine edges. Very compact in structure.

Silica	95.37	Sp. Gr.	2.49
Ox. Iron	2.40	Apparent Sp. Gr.	2.42
Lime	0.92	Absorbs	1.13 p. ct.
Magnesia	0.50	Cubic ft. weighs	151.01 lbs.
Loss by ignition	0.55	Loss by freezing	0.007 p. ct
	99.74		

No. 24.—Sandstone, Morrison, Jefferson County. Fine grain, rather porous. Color light yellow.

Silica	96.06	Sp. Gr.	2.47
Alumina & Ox. Iron	2.25	Apparent Sp. Gr.	2.15
Lime	0.81	Absorbs	6.00 p. ct.
Magnesia	0.32	Cubic ft. weighs	134.16 lbs.
Loss by ignition	0 60	Loss by freezing	0.022 p. ct
	100.04		

No. 25.—Sandstone, Morrison, Jefferson County. Effervesces with acids. Very similar to No. 13, in all respects. Light red color.

Silica	79.20	Sp. Gr.	2.48
Alumina & Ox. Iron	4.23	Apparent Sp. Gr.	2.22
Lime	8.44	Absorbs	4.64 p. ct.
Magnesia	0.93	Cubic ft. weighs	138.53 lbs.
Loss by ignition	6.60	Loss by freezing	0.120 p. ct
	99.40		

No. 26.—Sandstone, Morrison, Jefferson County. Dark red, very compact. Alkalies are in a micaceous mineral included, visible under glass.

Silica	74.02		
Ox. Iron	16.31		
Lime	1.91	Sp. Gr.	2.61
Magnesia	0.60	Apparent Sp. Gr.	2 54
Potassa	3.39	Absorbs	0.77 p. ct.
Soda	0.23	Cubic ft. weighs	158.50 lbs.
Loss by ignition	3.71	Loss by freezing	0.251 p.ct.
	100.17		

No. 27.—Sandstone, Morrison, Jefferson County. Coarse granules of quartz inclosed. Red.

Silica	68.56		
Ox. Iron & Alumina	20.63		
Lime	1.36	Sp. Gr.	2.64
Magnesia	0.80	Apparent Sp. Gr.	2.57
Potassa	2.21	Absorbs	0.85 p. ct.
Soda	2.25	Cubic ft. weighs	160.37 lbs.
Loss by ignition . . .	3.85	Loss by freezing	0.277 p. ct.
	99.66		

No. 28.—Sandstone, Morrison, Jefferson County. Nearly white, or pinkish white. Very friable.

Silica	95.70	Sp. Gr.	2.41
Alumina & Ox. Iron .	2.67	Apparent Sp. Gr.	2.17
Lime	0.96	Absorbs	4.64 p. ct.
Magnesia	0.14	Cubic ft. weighs	135.41 lbs.
Loss by ignition . . .	0.68	Loss by freezing	0.083 p. ct.
	100.15		

No. 32.—Sandstone, Morrison, Jefferson County. Dull white in color.

Silica	78.65		
Alumina	13.06		
Lime	1.65	Sp. Gr.	2.50
Magnesia	0.58	Apparent Sp. Gr.	2.17
Potassa	3.28	Absorbs	5.95 p. ct.
Soda	0.55	Cubic ft. weighs	135.41 lbs.
Loss by ignition . . .	1.86	Loss by freezing	0.174 p. ct.
	99.63		

No. 34.—Sandstone, unknown locality. Pinkish tinge, fine grain, compact, with sharp edges in cut stone.

Silica	94.55	Sp. Gr.	2.54
Ox. Iron & Alumina .	1.53	Apparent Sp. Gr.,	2.41
Lime	2.29	Absorbs	1.99 p. ct
Magnesia	0.21	Cubic ft. weight	150.38 ℔s.
Loss by ignition . . .	1.35	Loss by freezing .	0.119 p. ct
	99.93		

No. 35.—Sandstone, Dillon, Summit County. Firm texture, mottled with small spots of yellow (hydrated) oxide of iron and a darker (nearly black) mineral.

Silica	94.02	Sp. Gr.	2.50
Alumina & Ox. Iron .	3.40	Apparent Sp. Gr.,	2.41
Lime	1.72	Absorbs	1.52 p. ct
Magnesia	0.18	Cubic ft. weighs	150.38 ℔s.
Loss by ignition . . .	0.86	Loss by freezing,	0.040 p. ct
	100.18		

No. 36.—Sandstone, El Moro, Las Animas County. Porous, probably quite alkaine. Color light grey.

Silica	76.29	Sp. Gr.	2.46
Alumina & Ox. Iron .	15.91	Apparent Sp. Gr.,	2.12
Lime	0.91	Absorbs	5.89 p. ct
Magnesia	0.50	Cubic ft. weighs	132.29 ℔s.
Loss by ignition . . .	2.07	Loss by freezing,	0.471 p. ct
Alkalies not determined.			
	95.68		

No. 37.—Sandstone, Eureka. Very friable, yellowish white in color. Very similar in all respects to No. 14.

Silica	90.71	Sp. Gr.	2.40
Alumina & Ox. Iron	5.11	Apparent Sp. Gr.,	2.04
Lime	1.52	Absorbs	7.03 p. ct
Magnesia	0.23	Cubic ft. weighs	127.30 lbs.
Loss by ignition	2.58	Loss by freezing,	0.209 p. ct
	100.15		

No. 38.—Lava, Garfield Quarry, Douglas County. Pink color; in other respects resembles No. 6.

Silica	73.20	Sp. Gr.	2.14
Alumina & Ox. Iron	16.50	Apparent Sp. Gr.,	1.75
Lime	3.10	Absorbs	9.76 p. ct
Magnesia	1.45	Cubic ft. weighs	109.20 lbs.
Potassa	3.20	Loss by freezing,	0.161 p. ct
Soda	1.42		
Loss by ignition	0.75		
	99.62		

No. 39.—Lava, Curry Quarry, Douglas County. Grey color; in other respects resembles No. 38.

Silica	75.26	Sp. Gr.	2.23
Alumina & Ox. Iron,	14.15	Apparent Sp. Gr.,	1.91
Lime	2.02	Absorbs	7.36 p. ct
Magnesia	trace	Cubic ft. weighs	119.18 lbs.
Potassa	4.62	Loss by freezing,	0.200 p. ct
Soda	3.05		
Loss by ignition	1.03		
	100.13		

No. 40.—Sandstone, unknown locality. Light brownish red; very firm.

Silica	83.68	Sp. Gr.	2.46
Ox. Iron & Alumina	9.45	Apparent Sp. Gr.,	2.19
Lime	1.42	Absorbs	4.89 p. ct
Magnesia	0.90	Cubic ft. weighs	136.66 lbs.
Potassa	1.22	Loss by freezing,	0.135 p. ct
Soda	0.78		
Loss by ignition	2.01		
	99.46		

No. 50.—Sandstone; "Buckhorn Quarry," U. P. R. R; nearly white; highly siliceous.

Silica	96.45	Sp. Gr.	2.45
Ox. Iron	1.90	Apparent Sp. Gr.,	2.22
Lime	1.06	Absorbs	4.27 p. ct
Magnesia	0.64	Cubic ft. weighs	138.53 lbs.
	100.05	Loss by freezing,	0.018 p. ct

No. 60.—Sandstone; U. P. R. R. quarry, at Stout; grey color, with flecks of rust.

Silica	95.50	Sp. Gr.	2.49
Ox. Iron	0.78	Apparent Sp. Gr.,	2.35
Lime	0.88	Absorbs	2.35 p. ct
Magnesia	1.45	Cubic ft. weighs	146.64 lbs.
Loss by ignition	1.18	Loss by freezing,	0.015 p. ct
	99.79		

TESTING THE ROCK SAMPLES.

Specimens of Building Material Submitted For the Capitol Building.

A Table Showing the Strength of the Various Kinds of Granite and Sand-Stone. Brick Tests, Etc.

From Denver Tribune-Republican, July 1, 1885.

The tests of the samples of rock from which to select building material for the Capitol building have been made by State Engineer Nettleton. There were thirty-seven samples of building stone submitted to the Board of Capitol Managers, in answer to their card addressed to the quarry owners in this State and elsewhere.

Thirty of the samples are from the quarries within this State, and as a whole are much superior to those submitted to the Board two years ago.

Mr. Nettleton has made a thorough test and examination of all the qualities of the stone submitted that are usually made, except the chemical analysis; this will be made at the State School of Mines as soon as the school convenes after the present summer vacation. After this has been done a full and complete report will probably be made.

MAKING THE TEST.

All of the sample cubes were soaked twenty-four hours in water then put into a tin box and frozen by salt and ice; the temperature was suddenly brought down to zero and specimens were allowed to remain at this temperature for twenty-four hours, then they were put into a room at a temperature of 180 and there allowed to remain twenty-four hours. It was found that none of the cubes were cracked by the effects of the frost and none were in any way injured as far as could be detected. No loss had occurred in the weight of the cubes.

TESTS MADE OF BRICK.

The following brick tests were made:

Golden pressed brick, sample........ 4x4x2½
Pressure on sample........................48,750 pounds
Per square inch...............................3,045 pounds
Hallack's pressed brick.................. 4x4x2½
Pressure on sample.........................25,500 pounds
Per square inch.................................. 1,594 pounds
Common brick.. 4x4x2½
Pressure on sample........................16,000 pounds
Per square inch..................................1,000 pounds

SOME OF THE SAMPLES SUBMITTED.

The Georgetown Granite is being used in the new Government building, corner of Arapahoe and Sixteenth streets, and is greatly admired for its beauty and strength.

The Red Granite was used for the steps and fence of the Arapahoe County Court House and columns of the Barclay Block on Larimer street.

The Bradford Quarry Sandstone was used in the construction of the Arapahoe County Court House.

The Emerins Manitou Quarry Sandstone in the construction of the Tabor Opera House building.

The Trinidad Quarry Sandstone in the construction of the *Times* building on Lawrence street.

The Red Sandstone from Douglass county in the construction of the new Board of Trade building, corner of Fourteenth and Lawrence streets.

The Oak Creek Sandstone, Fremont county, was used in the construction of the Barclay Block on Larimer street.

The Stout and Buckhorn quarries, of Larimer county, furnish most of the stone for foundations and side walls in the business portion of the city. Some has also been used for the superstruction of buildings. It is one of the most substantial stones used.

The limestone from Clements, Kansas, is being used in the construction of the State Capitol building at Topeka, Kansas.

The Oolites limestone from Salem, Indiana, has been used for the past thirty years in the construction of public buildings, and the new State Capitol building at Atlanta, Georgia, is being built of this stone.

The limestone from Lemont, Illinois, is a stone which has been extensively used in the public buildings of Chicago and elsewhere.

The Wyoming sand stone has been used in the public buildings at Cheyenne and along the line of the Union Pacific railroad.

The blue sand stone is used at the State Penitentiary at Canon City.

The following is the table showing the tests made on the rock samples:

No. of Specimen...	LOCALITY.	COLOR.	Position..............	Size in inches...	Strength of the specimen in lbs...	Strength of one squre inch in lbs.	Specific gravity.....	Weight of one cubic foot in lbs..	Ratio of absorption in 10 minutes....	Ratio of absorption in 24 hours.......	REMARKS.	
41½	Grape Creek............	Pinkish gray.....................	Bed Edge	2.03x2.04 2.05x2.07	60,000 73,750	14,492 17,352	2.603	162.375	....	.048	Gneiss............	Broke suddenly into wedges and parallel pieces
42	Brownsville............	Mottled gray.....................	Bed Edge	2.02x2.03 2.02x2.03	62,500 85,000	15,244 20,731	2.700	168.426	....	.004	Granite.........	Broke suddenly into large pieces and wedges. Broke suddenly into smaller pieces and wedges.
43	Brownsville............	Mottled gray.....................	Bed Edge	2.07x2.08 2.08x2.09	67,500 90,000	15,625 20,694	2.713	169.236	....	.004	Grantite.......	Broke suddenly into large pieces. Broke suddenly into thin pieces.
44	Lawson....................	Light gray..........................	Bed Edge	2.00x2.07 1.97x2.06	72,500 74,000	17,512 18,226	2.629	163.997	....	.006	Granite.	Broke suddenly into fine fragments.
45	Platte Canon...........	Pink......................................	Bed Edge	1.97x2.08 2 04x2.00	65,000 60,000	14,585 14,634	2,625	163.747	....	.006	Granite.........	Broke into coarse pieces and wedges. Broke suddenly into fine pieces.
46	Cotopaxi..................	Mottled gray.....................	Bed Edge	1.99x2.00 1.99x1.98	74,250 92,500	18,654 23,358	2.667	166.367	....	.003	Granite.........	Broke suddenly into coarse, irregular-shaped fragments
47	Monarch..................	Dark mottled gray..........	Bed Edge	2.03x2.03 2.00x2.02	62,500 71,500	15,170 17,698	2.760	172.168	....	.012	Granite.........	Broke into wedges and flat pieces suddenly. Broke into wedges and flat pieces suddenly.
48	Gunnison.................	Dark mottled gray..........	Bed Edge	2.04x2.06 2.02x2.04	52,500 64,250	12,976 15,594	2.715	169.361	....	.006	Granite.........	Broke into large fragments and wedges. Broke suddenly.
49	Thistle, Utah...........	Varegated and ornamental	Bed Edge	2.00x2.03 2.05x2.02	75,000 75,000	18,473 18,029	2.687	167.240	....	.003	Marble..........	Broke suddenly into small fragments.
50	Buck Horn..............	Grayish white..................	Bed Edge	2.05x2.07 2.04x2.06	78,750 72,500	18,573 17,261	2.379	168.402	.011	.040	Sandstone....	Broke into wedges and sand. Broke suddenly.
51	Thistle, Utah...........	Dark redish brown..........	Bed Edge	2.06x2.06 2.02x2.04	35,000 38,750	8,254 9,405	2,407	150.211	.024	.063	Sandstone	Crushed into large wedge, not suddenly. Crushed into large wedge, not suddenly.
52	Trinidad	Drab.....................................	Bed Edge	2.01x2.03 1.94x2.00	41,250 37,500	10,110 9,665	2 339	145.906	.009	.069	Sandstone	Crushed into sand and large wedges Crushed into parallel pieces and wedges.
53	Manitou (Snider)......	White..................................	Bed Edge	2.01x2.05 2.06x2.07	53,750 48,750	13,046 11,442	2.207	137,672	.071	.094	Sandstone	Broke suddenly into thin pieces. Broke suddenly into wedge-shaped pieces and sand.
54	Ralston....................	Red......................................	Bed Edge	2.04x2.04 1.99x2.02	46,250 39,000	11,118 9,701	2.245	140.043	.062	.080	Sandstone	Broke suddenly into fine fragments and sand. Broke into wedge-like pieces.
55	Left Hand................	Pink......................................	Bed Edge	1.98x2.00 2.03x2.03	45,000 56,250	11,278 13,653	2 240	139.731	.023	.042	Sandstone	Broke into large irregular pieces. Broke into fine fragments.
56	St. Vrains................	Light red............................	Bed Edge	2.00x2.01 2.00x2.04	46,250 71,500	11,505 17,187	2.393	149.275	.012	.061	Sandstone	Broke suddenly into wedge-like pieces. Broke suddenly into finer pieces.
57	Douglas County........	Red......................................	Bed Edge	2.04x2.01 2.02x2.02	14,250 14,250	3,544 3,492	2.191	136.674	.088	.134	Sandstone.....	Crushed into irregular pieces and sand.
58	Fort Collins.............	Gray.....................................	Bed Edge	2.03x2.05 2.00x2.04	48,750 44,000	11,707 10,784	2.252	40.679	.013	.072	Sandstone.....	Broke into irregular fragments and sand.
59	Fort Collins.............	Light red............................	Bed Edge	2.00x2.01 1.99x1.99	51,250 69,250	12.740 17,487	2.432	151.648	.011	.051	Sandstone.....	Broke into irregular fragments and sand.
60	Stout	Dark gray...........................	Bed Edge	2 07x2.07 2.08x2.10	45,000 55,000	10,514 12,585	2.263	141.165	.040	.066	Sandstone.....	Broke into irregular fragments and sand.
61	Coal Creek..............	Greenish gray...................	Bed Edge	2.02x2 02 1.96x2.01	11,750 9,500	2,879 2,411	2.033	126.818	.053	.167	Sandstone.....	Crushed without noise into sand and irregular fragments
62	Oak Creek...............	Yellowish gray..................	Bed Edge	2.03x2.04 2.02x2.03	11,000 10,000	2,657 2,475	1.953	121.828	.076	.193	Sandstone.....	Crushed without noise into sand and irregular fragments
63	Coal Creek..............	Greenish gray...................	Bed Edge	2.05x2.05 2.03x2.04	15,000 14,000	3,570 3,381	2.067	128.939	.055	.158	Sandstone.....	Crushed without noise into sand and irregular fragments
64	Gunnison.................	Brownish gray, speckled...	Bed Edge	2.02x2.02 2.00x2.01	25,000 21,000	6,127 5,224	2.066	128.877	.128	.146	Sandstone.....	Broke suddenly into irregular pieces.
65	Dunlap, Kansas........	Cream white.....................	Bed Edge	1.96x2.02 1.92x1.96	35,000 28,250	8,838 7,513	2.302	143.598	.052	.116	Limestone.....	Crushed into small fragments.
66	Clements, Kansas.....	Cream white.....................	Bed Edge	2.05x2.06 1.99x2.03	29,250 27,000	6,931 8,881	2.210	137.859	.067	.135	Limestone.....	Crushed into coarse fragments and dust.
67	Salem, Indiana.........	Gray.....................................	Bed Edge	2.00x2.01 2.00x2.00	35,000 27,500	8,706 7,125	2.315	144.409	.072	.109	Limestone.....	Crushed into coarse fragments and dust.
68	Morrison, Colorado...	White..................................	Bed Edge	1.98x2.02 2.00x2.01	47,500 50,000	11,875 12,437	2.336	145.719	.045	.122	Limestone.....	Broke suddenly into small fragments.
69	Lemont, Illinois......	Light gray..........................	Bed Edge	1.99x2.01 1.96x1.99	57,000 45,000	14,250 11,538	2.553	159.256	.016	.066	Limestone.....	Broke suddenly. Broke into thin, flat pieces.
70	Canon City..............	Cloudy blue......................	Bed Edge	1.99x2.00 1.95x1.91	22,750 14,250	5,716 3,820	2.301	143.536	.061	.100	Sandstone.....	Broke into small irregular pieces.
71	Manitou (Emerins)...	White	Bed Edge	1.97x2.03 2.01x1.96	37,000 40,000	9,250 10,152	2.233	139.294	.077	.120	Sandstone.....	Broke suddenly into small fragments.
72	Gunnison.................	White..................................	Bed Edge	1.98x2.02 2.02x1.96	21,000 21,750	5,250 5,492	2.204	137.485	.087	.090	Sandstone.....	Crushed suddenly into fine pieces and sand.
73	La Porte, Colorado...	Pink....................................	Bed Edge	2.03x2.04 2.03x2.00	43,750 35,000	10,567 8,620	2.235	145.033	.031	.079	Sandstone.....	Broke into irregular-shaped pieces.
74	Brandford................	Greenish gray...................	Bed Edge	2.01x2.02 2.02x2.01	13,500 11,750	3,308 2.894	2.004	125.009	.071	.189	Sandstone.....	Crushed into irregular-shaped pieces and sand.
75	Wyoming.................	Gray.....................................	Bed Edge	2.06x2.02 2.01x2.03	45,500 38,750	10,833 9,544	2.021	126.069	.102	.217	Sandstone.....	Broke into large fragments and wedges.
76	Left Hand................	Cream gray........................	Bed Edge	1.99x2.04 2.04x1.95	50,000 52,000	11,848 13,056	2.394	149.237	.011	.049	Sandstone.....	Broke suddenly into wedges and small fragments.
77	Left Hand................	Light pink..........................	Bed Edge	2.02x1.97 2.01x2.04	54,000 36,250	13,300 8,841	2.290	142·850	.026	.054	Sandstone.....	Broke suddenly into wedges.