State of Nevada
Department of Highways
Materials and Testing Division

METHOD FOR DETERMINATION OF COMPRESSIVE STRENGTH OF CEMENT TREATED BASE AND CEMENT TREATED SUBGRADE (FIELD METHOD)

SCOPE

This method covers the procedure for determining the compressive strength of cement treated material, and also provides a guide for maintaining optimum moisture conditions in the field.

FIELD METHOD

A. APPARATUS

1. Balance with capacity of 5,000 g, accurate to 1 g
2. Split compaction mold, 4-in. diam. x 11.5 in. as shown in Figure I.
3. One compression machine consisting of a 12-20 ton capacity hydraulic jack fitted with a spherically seated head and mounted in a 30-in. frame.
4. Tamper, rod, tin liners and bottom and upper plunger as shown in Figure I.
5. Measuring gauge and stand as shown in Figure II.
6. Special bench vise for holding compaction and mold as shown in Figure II.
7. 6 x 12-in. concrete cylinder cans with lids.
8. Two 6 x 6-in. glass plates for each specimen.
9. Miscellaneous items such as spoons, spatulas, scoops, scotch tape, etc.
10. Water tank 6-in. deep for use in submerging test specimens.
11. Sample splitter, riffle type, 3/4-in. openings.

B. MATERIALS

1. A supply of gypsum casting plaster.
2. Supply of 1/2-in. adhesive tape.

C. PROCEDURE FOR THE FABRICATION OF TEST SPECIMENS

1. Obtain representative samples of the freshly mixed materials daily. Normally, two samples should be taken, one from the mixing plant and one from the street immediately ahead of rolling operations. To protect against the loss of moisture, place all samples in 6 x 12-in. concrete cylinder cans and immediately cover.

2. Transport the cans to the point of fabrication and fabricate samples with the least possible delay. Protect against loss of moisture at all times.

3. Immediately upon arrival at the point of fabrication, remix the sample and screen through a 1-in. sieve. Only the minus 1-in. material is used in making test specimens.

4. Quarter out the approximate amounts required for the moisture determination and test specimen. The amount of material for moisture samples should be approximately 1,000 g. The amount of material needed for fabricating a test specimen is shown in Table II. It is of extreme importance that test specimens be fabricated as soon as possible after the mixing process. The hydration of the cement can cause a serious loss of compressive strength as well as a reduction in the density of the test specimen.

5. Weigh the material for both moisture samples and test specimens to the nearest gram, and weigh as rapidly as possible to avoid loss of moisture. Protect all material for test specimens against loss of moisture after weighing, and do not delay between weighing and fabricating.

6. Assemble the 4-in. mold with the tin liner in place and the plunger held one space from the bottom by means of the pin. (For some soils it may be necessary to hold the bottom plunger further from the end of the mold in order to prevent the rim of the mold from coming in contact with the shoulder of the plunger before compaction is completed. In such cases, insert the pin through successively higher holes until satisfactory results are secured).

7. Place the extension sleeve on top of the mold and add approximately one-half of the weighed sample with a scoop or large spoon. If the material contains rock particles larger than 1/4 in., rod 25 to 30 times with a 3/8 in. bullet-nosed rod during this operation, in order to prevent the formation of rock pockets at the bottom or sides of the specimen. Tamp the first layer of material 50 blows with the small end of the 6 lb. hand tamper. Physical exertion in tamping should be only sufficient to move the tamper over the entire surface of the specimen. The actual compactive effort should be provided only by the weight of the tamper, using the hand as a guide. Avoid having a smoothly compacted surface at this stage because it will result in a compaction plane in the specimen when the next layer is tamped, and this would prevent the two layers from being bonded together.

8. Place the remaining portion of the sample in the mold and rod if sample contains coarse aggregate. It is not necessary to rod fine material such as

sand. Tamp the second layer using 100 blows with the small end of the hand tamper. Level off the top of the compacted specimen by tamping lightly with the large end of the tamper in order to provide a smooth surface on an even plane at right angles to the axis of the mold. After tamping is completed, remove the extension sleeve.

9. Place the top plunger in position, then place the entire assembly on the hydraulic jack in the compression frame. If necessary, place one or more of the spacing rings between the top plunger and the top of the frame to prevent excessive travel of the jack. Remove the pin that holds the bottom plunger in place and gradually apply a total load of 25,000 lb.; use 1 min. to attain the first 20,000 lb., 1/2 min. for the next 5,000 lb. and hold the 25,000 lb. load for 1 min. Then release the load, place the mold in the vise, take out the plungers, open the mold, remove the specimen with its tin jacket and weigh.

10. Determine the height with the measuring gauge, by seating the circular measuring guide firmly on top of the cylinder. Care must be taken to seat the dial indicator tip properly in the center of the measuring guide. The height measurement is illustrated in Figure II.

11. If water is squeezed out of the specimen during compaction, a notation should be made of the amount as a guide in maintaining optimum moisture control in the field. This is done by taking the difference between the net weight of the specimen and the net weight of the sample used. Headquarters laboratory will normally make optimum moisture determination on preliminary samples which may serve to compare with field results. However, in applying optimum moisture control in the field, consideration must be given to evaporation losses in mixing and handling and allowances made accordingly.

12. Determine the moisture content of the sample by weighing the material set aside for this purpose (approx. 1,000 g.) to the nearest gram and drying on a hot plate to constant weight.

$$\text{Percent moisture} = \frac{\text{Wet Weight - dry weight}}{\text{Dry weight}} \times 100$$

13. After determining the height and weight of the compacted specimen, print the proper identifying marks on the side of the tin liner with an indelible pencil. Place tin caps on each end and seal with masking tape.

D. PROCEDURE FOR THE DETERMINATION OF COMPRESSIVE STRENGTH IN THE FIELD

1. If it is necessary that compressive strengths be determined on the job, the test specimens should be cured for 6 days. The curing shall be accomplished by placing lids on each end of the tin sleeve, sealing with adhesive tape and then storing in a cool place such as the shady side of a building. However, during cold weather the test specimens should be protected from freezing. At the end of the 6-day curing period, remove the caps and liners and transfer the identifying marks to the side of the specimen with an indelible pencil.

2. Immerse the specimens in water for 1 day in order to complete the 7-day curing period required for the compressive strength test.

3. Remove the specimens from the water bath, wipe the surfaces with a dry rag and cap both ends of each specimen with gypsum casting plaster as follows:

   a. Select two glass plates, approximately 6 x 6 in., for each specimen and lay them out on a table or bench.

   b. Oil the top of each glass with common motor lubricant.

   c. Measure out into a suitable container about a cup of gypsum casting plaster for each specimen to be capped.

   d. Add water and mix to a fairly thick paste.

   e. Place a tablespoonful of paste on top of each test specimen and immediately force one of the plates down on the paste on top of each specimen to form full caps.

   f. Place a tablespoonful of paste on each of the other glass plates and press each of the specimens firmly on a glass plate so as to form full caps.

   g. Allow the caps to harden for a minimum of 30 min. and then remove the glass plates by tapping the edges lightly with a piece of soft wood. If difficulty is experienced in removing the plates, apply warm water and continue tapping lightly.

4. The specimen may be tested for compressive strength as soon as the glass plates are removed. Center the specimen on the head of the hydraulic jack in the compression machine and apply the load at the rate of between 20 and 50 lb. per square inch per second. A convenient rate of loading when using the compression machine on a 4-in. diam. test specimen is 30,000 lb. per minute. This allows easy conversion in the field to desired load-time units (i.e., 500 lb. per second). Apply the load until ultimate fracture of the test cylinder occurs. An initial fracture will usually occur at approximately 80 percent of the load required for ultimate fracture.

5. Report the test results as compressive strength in pounds per square inch which equals the total compression load divided by the end area of the 4-in. dia. test specimen (12.57 sq. in.). Table I lists the unit compressive stress in increments of 500-lb. total load.

TABLE I

TABLE OF UNIT COMPRESSIVE STRENGTH 4-IN. DIAMETER
CEMENT TREATED BASE SPECIMEN

Total Load (lbs.)	Compressive Strength (psi)	Total Load (lbs.)	Compressive Strength (psi)	Total Load (lbs.)	Compressive Strength (psi)
500	40	10,500	840	20,500	1,640
1,000	80	11,000	880	21,000	1,680
1,500	120	11,500	920	21,500	1,720
2,000	160	12,000	960	22,000	1,760
2,500	200	12,500	1,000	22,500	1,800
3,000	240	13,000	1,040	23,000	1,840
3,500	280	13,500	1,080	23,500	1,880
4,000	320	14,000	1,120	24,000	1,920
4,500	360	14,500	1,160	24,500	1,960
5,000	400	15,000	1,200	25,000	2,000
5,500	440	15,500	1,240	25,500	2,040
6,000	480	16,000	1,280	26,000	2,080
6,500	520	16,500	1,320	26,500	2,120
7,000	560	17,000	1,360	27,000	2,160
7,500	600	17,500	1,400	27,500	2,200
8,000	640	18,000	1,440	28,000	2,240
8,500	680	18,500	1,480	28,500	2,280
9,000	720	19,000	1,520	29,000	2,320
9,500	760	19,500	1,560	29,500	2,360
10,000	800	20,000	1,600	30,000	2,400

PROCEDURE FOR DETERMINING THE DENSITY OF TEST SPECIMENS

The density of the test specimen, based on the dry weight of material, is calculated from the data obtained in the Procedure for the Fabrication of Test Specimens using the following formula:

$$D = \frac{30.3\ Ww}{(100 + M)H}$$

Where:

D = Dry density of the test specimen in lb. per cu. ft.

Ww = Wet weight of the test specimen in grams.

M = Percent moisture of the sample.

H = Height of the test specimen in inches.

30.3 = Constant used to convert weight in grams to pounds per cubic foot for a 4-in. diam. specimen having the height measured in inches.

REFERENCE

Test Method Nev. 203
Test Method No. Calif. 901
Test Method No. Calif. 905

TABLE II

TABLE OF WEIGHTS FOR FABRICATING 4-IN. DIAMETER X 4-IN. HIGH TEST SPECIMENS OF VARIOUS WEIGHTS PER CU. FT.

Density lbs./cu.ft.	Total Grams CTB						
	6% moist.	7% moist.	8% moist.	9% moist.	10% moist.	11% moist.	12% moist.
115	1609	1624	1640	1655	1670	1685	1700
116	1623	1639	1654	1669	1684	1700	1715
117	1637	1653	1668	1684	1699	1714	1730
118	1651	1668	1682	1698	1714	1729	1745
119	1665	1681	1697	1712	1728	1744	1759
120	1679	1695	1711	1727	1743	1758	1774
121	1693	1709	1725	1741	1757	1773	1789
122	1707	1723	1739	1756	1772	1788	1804
123	1721	1737	1754	1770	1786	1802	1819
124	1735	1752	1768	1784	1801	1817	1833
125	1749	1766	1782	1799	1815	1832	1848
126	1763	1779	1796	1813	1829	1846	1863
127	1777	1793	1810	1827	1844	1860	1877
128	1791	1808	1825	1842	1859	1876	1893
129	1805	1822	1839	1856	1873	1890	1907
130	1819	1836	1853	1870	1888	1905	1922
131	1833	1850	1867	1885	1902	1919	1936
132	1847	1864	1881	1899	1916	1934	1951
133	1861	1879	1896	1914	1932	1949	1967
134	1875	1893	1911	1928	1946	1964	1981
135	1889	1907	1925	1942	1960	1978	1996
136	1903	1921	1939	1957	1974	1992	2010
137	1916	1935	1953	1971	1989	2007	2025
138	1931	1950	1968	1986	2004	2022	2041
139	1945	1963	1982	2000	2018	2037	2055
140	1959	1977	1996	2014	2033	2051	2070
141	1973	1992	2010	2029	2048	2066	2085
142	1987	2006	2025	2043	2062	2081	2100
143	2001	2020	2039	2058	2077	2095	2114
144	2015	2034	2053	2072	2091	2110	2129
145	2029	2048	2067	2087	2106	2125	2144
146	2043	2062	2082	2101	2120	2139	2159
147	2057	2076	2096	2115	2135	2154	2173
148	2071	2091	2110	2130	2149	2169	2188
149	2085	2105	2124	2144	2164	2183	2203
150	2099	2119	2139	2158	2178	2198	2218

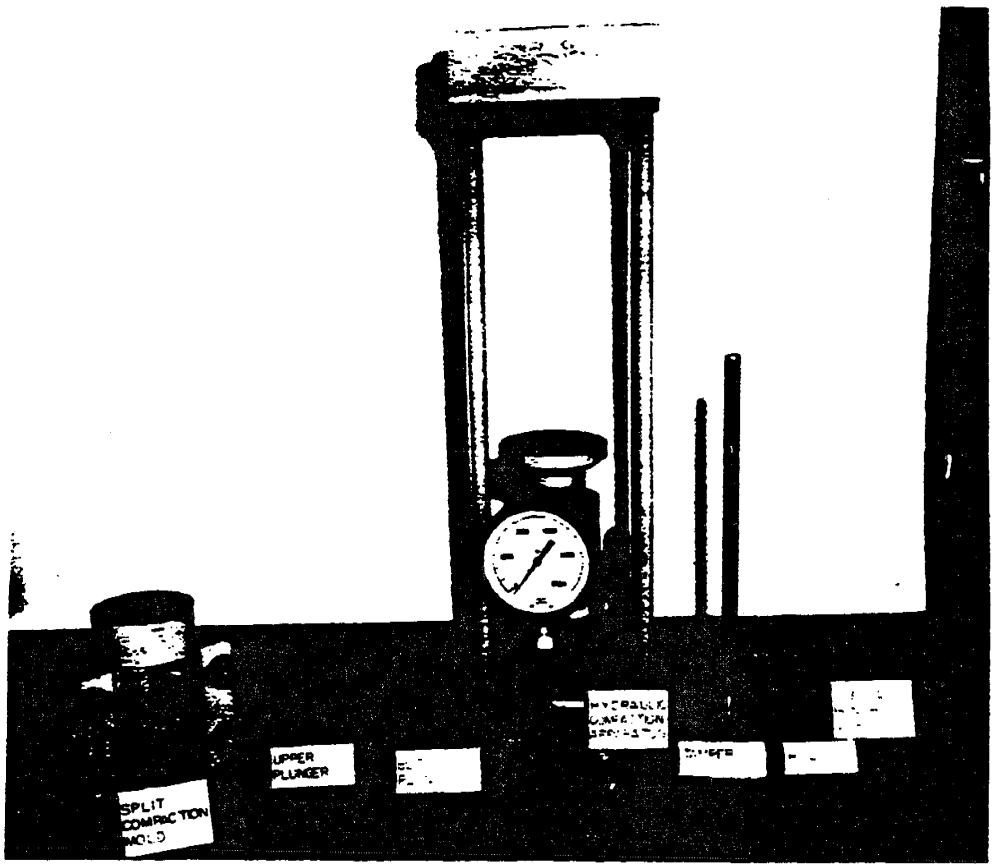

FIGURE 1

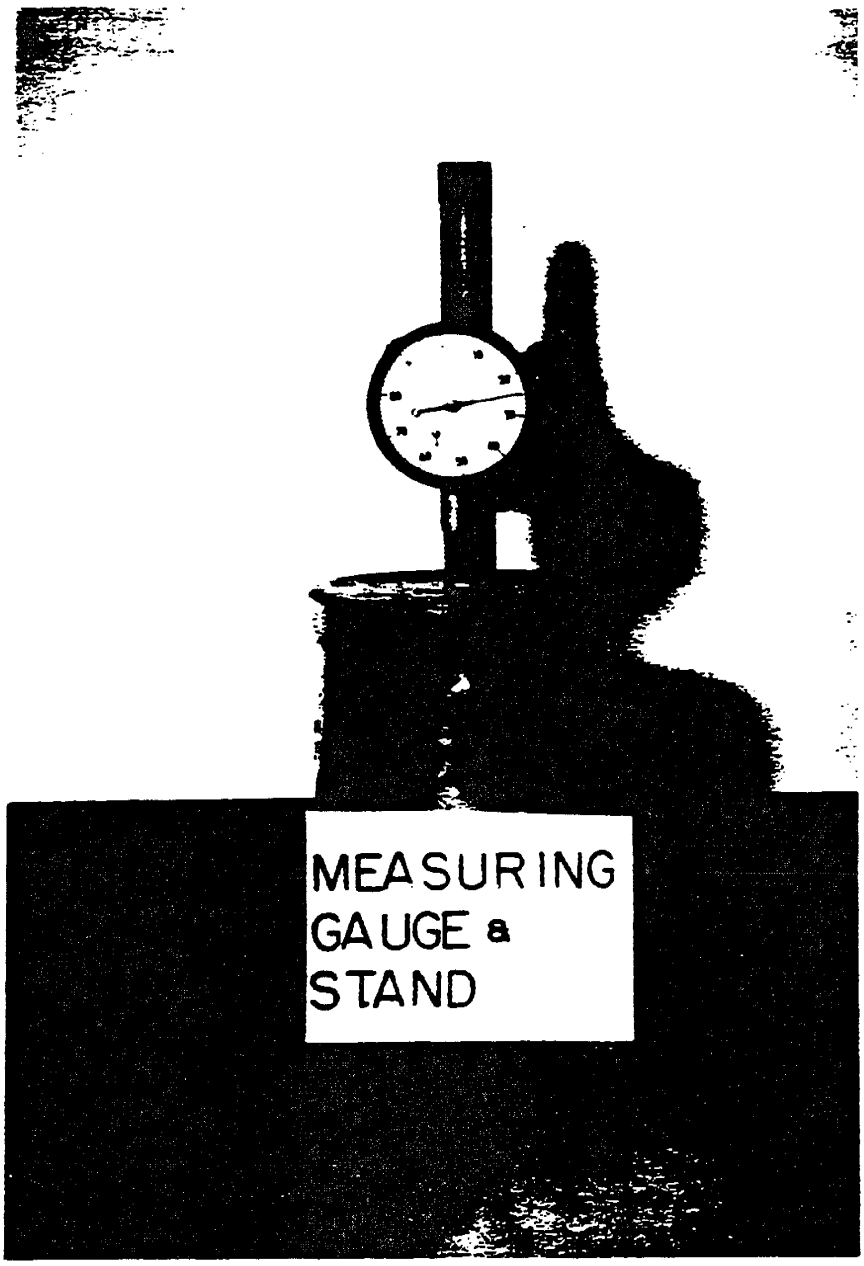

FIGURE 2