With reference to question No 4, a few of the articles published are as follows Apparatus for Measuring the Wear of Concrete Roads, A T Goldbeck, Journal of Agricultural Research, Feb 14, 1916, A Pavement Determinator, Concrete-Cement Age, Dec 1912, A Pavement Testing Machine of the National Physical Laboratory, New York Commissioner of Highways Report, 1913, Vol II

ABSORPTION OF CONCRETE IN WATER AS AFFECTED BY AGGREGATES—ITS ULTIMATE EFFECT IN EXPANSION OF ROAD SLABS

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Published information—There is very little published information on this subject In practically all concrete investigations care has been taken to use only one class of aggregate

University of Minnesota Studies in Engineering by Professor C F Shoop, published in 1915

Tables showing absorption of concrete when same sand and cement was used, but different coarse aggregates, do not show high absorption in concrete to correspond to absorption of stone Tables show higher strengths for concrete made with porous rocks for coarse aggregate

Table 5, page 24, Bulletin No 2, Structural Materials Research Laboratory of Lewis Institute, gives some absorption comparisons between pebbles and limestone

Bulletin 532 of the U S Department of Agriculture is on the expansion and contraction of concrete and concrete roads The possible effect of different aggregates is not investigated

University of Illinois, Bulletin No 126, "A Study of the Effect of Moisture Content upon the Expansion and Contraction of Plain and Reinforced Concrete" In this investigation the same materials were used Curves on pages 9 and 10 of that bulletin show that the expansion and contraction during curing period is greater for mortar than it is for concrete Curves on page 14 of the bulletin indicate that the expansion of mortar due to absorption of moisture is much greater than it is for concrete This curve shows that a 1 2 4 concrete absorbed 5 4 per cent moisture in ten days and showed a unit expansion ranging from 00026 to 0003 The 1 2 mortar showed an absorption of 6 8 per cent in ten days and a unit expansion of 0 00068 On pages 17 and 18 of the bulletin is shown the expansion due to absorption of a sandstone and a limestone The sandstone had high absorption with corresponding expansion, the limestone had high absorption with very little expansion

Bulletin 537 of the U S Department of Agriculture gives the absorption of a great many rocks

The writer was unable to find any information on the expansion of rocks as a result of absorption except for the limestone and sandstone in Bulletin No 126, University of Illinois.

Table 1, Bulletin No 10, Structural Materials Research Laboratory of Lewis, Institute, shows compressive strength for various coarse aggregates

The Minnesota Highway Department in 1922 made compression tests on concrete cylinders in which the coarse aggregate was the only variable The porous rocks show highest compressive strength This test is only part of a general investigation on Effect of Weathering which has not yet been completed

Research under way —The writer has been unable to find any record of any investigations on this subject being carried on at the present time

Desirability of further research —Some concrete pavements have buckled The writer considers that the kind of coarse aggregate may have been a factor The following are suggested as items on which further information is desirable

1 Effect of porosity of coarse aggregate on strength of concrete when dry and when saturated
2 Effect of absorption of coarse aggregates on bond between coarse aggregate and mortar
3 Amount of expansion due to absorption and temperature changes of concrete when different coarse aggregates are used keeping mortar content constant
4 Effect of difference in modulus of elasticity of coarse aggregate and mortar
5 Expansion of different rocks due to absorption

DECREASED STRENGTH OF CONCRETE WHEN WET

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The following papers show results that indicate the decreased strength of concrete when wet

"The Effect of Saturation on the Strength of Concrete" J L Van Ornum, Washington University, St Louis, Missouri Journal of the Association of Engineering Societies, 1913

Results

1. "The compressive strength of concrete exposed to air may be reduced 40 per cent when saturated with water"
2 Bond tests "indicate clearly for both plain and deformed bars, that the bond strength values decline rapidly and then increase slowly after saturation" (for air-cured concrete). Average minimum was only about 75 per cent of that of the air-cured specimens.
3 Beam tests indicate about ¾ of the air-cured strength when immersed

"Effect of Moisture on the Strength of Concrete" Sherman M. Woodward and Frederick C Young, State University of Iowa, Iowa City, Iowa Engineering News, 1913