Inputs of Portland cement concrete parameters needed for the design of new and rehabilitated pavements in Mississippi

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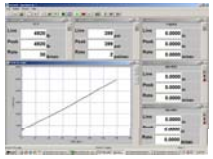
ASTM C469 Modulus of Elasticity and Poisson's Ratio

Scope

This test is used to determine the modulus of elasticity (MOE) and Poisson's ratio of hardened cylindrical concrete specimens when subjected to longitudinal compressive stress. These values may be used in sizing of structural members, establishing quantity of reinforcement and computing stresses for observed strains. MOE is a key input in the new mechanistic-Empirical Pavement Design Guide.

Test Setup





Procedures

1. Place the specimen on the lower steel cap on the test machine.
2. Attach the LVDTs to the compressometer/extensometer
3. Carefully align the axis of the specimen with the centerline of the upper thrust block of the crosshead.
4. Bring the upper platen to bear on the specimen, adjusting the load to obtain uniform seating of the specimen.
5. Lower the crosshead down until contact is almost made with the steel cap.
6. Start the computer and the ADMET MTESTWindows software and set the parameters.
7. Load the specimen at a rate of 35 psi per second (990 lb/s) until a load of 40% of ultimate is reached.
8. Stop loading and save the result file.

ASTM C39 Compressive Strength

Scope

Compressive is frequently used in design calculations for concrete pavements, and is a key input in the new Mechanistic-Empirical Pavement Design Guide. Compressive strength may be defined as the measured maximum resistance of concrete to axial loading. It is generally expressed in pounds per square inch (psi) at an age of 28 days. Compression tests of concrete are made on 6x12-in.or 4x8-in. cylinders molded from fresh concrete or cylindrical cores drilled from hardened concrete. The loading rate should be adjusted so that the specimen fails within 2 to 3 minutes. The target loading rate for the 6*12 concrete specimen is 1000 lbs/sec.

Test Setup



Procedures

1. Maintain the specimen in a moist condition before the specimen is tested.
2. Wipe clean the bearing surfaces of the upper and lower platens of the compression testing machine. Also, wipe clean both ends of the test specimen.
3. Place the steel ring cap with rubber pad in the lower position of the testing machine, place the specimen on the cap.
4. Carefully center the specimen on the testing machine.
5. Carefully align the axis of the specimen with the center of thrust of the spherically seated upper platen.
6. Place the steel ring and rubber pads on the upper end of the specimen and center them.
7. Bring the upper platen to bear on the specimen, adjusting the load to obtain uniform seating of the specimen.
8. Start the computer and the ADMET MTESTWindows Material Testing system software and set the parameters.
9. Apply the load at a loading rate of 560 to 1400 lb/s for 6" diameter cylinders (20-50 psi/ s), the target loading rate is 1000 lbs/s.
10. Apply the load at the prescribed loading rate until the specimen fails, stop the machine and save the corresponding file.
11. Note the type of failure and the appearance of the concrete.

ASTM C78 Modulus of Rupture

Scope

Flexural strength in bending is commonly used in the design of pavements and other slabs on the ground. Flexural strength tests are typically performed on cured 6x6x24-in beams molded from fresh concrete. Test results are calculated and reported as the modulus of rupture. ASTM C78 requires that the specimen fails with a crack on the middle range of the bottom. The modulus of rupture can be calculated by the ultimate loading obtained.

Test Setup

Procedures

1. Position the specimen in the testing machine. Center the loading apparatus in relation to the applied axial force.
2. Bring the load-applying block in contact with the upper surface of the specimen at the third points between the lower supports. The span distance between the lower supports is 18 in.
3. Start the computer and the ADMET MTEST Windows software and set the parameters.
4. Apply the load continuously at a rate that increases the extreme fiber stress to a value between 125 to 275 psi/minute until rupture occurs (the load rate is 1500 to 3300 lb/minute for 6" by 6" beams with a span of 18").
5. If the fracture (rupture) occurs in the tension surface (the bottom surface) outside the middle third of the span length by more than 5% of the span length (about 1 in.), discard the result of the test.
6. Stop loading and save the result file.
7. Calculate the modulus of rupture (MOR), neglecting the beam weight, as follows: $MOR = \frac{Pl}{bd^2}$

ASTM C496 Splitting Tensile Strength

Scope

This method consists of applying a diametral compressive force along the length of a cylindrical specimen. This loading induces tensile stresses on the plane containing the applied load. Tensile failure occurs rather than compressive failure. Plywood strips are used so that the load is applied uniformly along the length of the cylinder. The maximum load is divided by the appropriate geometrical factors to obtain the splitting tensile strength.

Test Setup

Procedures

1. Draw diametral lines on each end of the specimen so that they are in the same axial plane.
2. Center one of the plywood strips along the center of the lower bearing block.
3. Place the specimen on the plywood strip and align so that the lines marked on the ends are vertical and centered over the plywood strip.
4. Place the second plywood strip and the bearing bar so that they are lengthwise on the cylinder, centered on the previously marked lines on the ends.
5. Start the computer and the ADMET MTEST Windows software and set the parameters.
6. Apply the load continuously at a constant rate of 100 to 200 psi/minute of splitting tensile stress until failure occurs.
7. Stop loading and save the result file.
8. Calculate the splitting tensile strength as follows: $f'_{st} = \frac{2P}{\pi \ la}$

ASTM C157 Shrinkage

Scope

This test is used to determine the length changes produced by causes other than externally applied forces and temperature changes in concrete specimens and exposed to controlled conditions of temperature and moisture. Concrete expands when stored in moisture and contracts in air dry condition. In order to measure these changes, 3"x 3" x 11.25" concrete bars will be cast and stored in both lime saturated water and in air. For those stored in air, the length of the specimen will be measured at age 28 days, then after 4,7,14, 28 days, 8 weeks, 16 weeks, 32 weeks and 64 weeks. Specimens in water are measured at age 4 weeks, 16 weeks, 32 weeks, and 64 weeks.

Test Setup

Procedures

1. Place the comparator frame on a stable surface.
2. Use the Standard Invar Test Bar to check the length comparator. If needed, adjust the lower anvil to obtain a proper reading on the digital indicator.
3. Get a specimen and bring it to the instrument with the indicator retracted. The specimen is set in the lower anvil and the indicator is released very slowly and carefully until there is contact with the upper anvil.
4. Record the reading.
5. Test 5 specimens within 15 minutes.

Input Parameters Used for Design of Pavement in Mississippi for Typical Concrete used

Mix No.	Compressive Strength (psi)	Flexural Strength (psi)	Splitting Tensile Strength (psi)	Modulus of Elasticity (psi)	Poisson's Ratio	Coefficient of Thermal Expansion	Unit Weight (lb/ft^3)
1	5456	554	363	5604164	0.17	7.981	146
2	5668	598	418	5487278	0.17	8.513	147
3	5506	596	402	5518442	0.19	8.022	142
4	5692	714	455	5882199	0.18	7.943	146
5	5674	740	432	5405447	0.19	6.312	144
6	5724	689	430	5448507	0.17	6.186	146
7	5899	748	389	5276084	0.22	6.106	147
8	5734	855	510	5480000	0.26	6.05	145
9	5617	760	474	5630902	0.24	6.36	146
10	6089	776	487	6027757	0.22	6.631	150
11	7260	748	477	5736640	0.24	6.667	148
12	6747	910	485	5908602	0.2	6.564	147
13	5789	631	398	5854845	0.14	5.968	147
14	5918	684	448	5829696	0.18	7.899	145
15	5850	695	424	5725702	0.16	8.224	146
16	5518	768	437	5509169	0.19	7.963	146
17	5887	707	426	5410646	0.18	8.748	141
18	5550	682	422	5333850	0.17	6.772	143
19	5813	649	440	5201584	0.18	7.255	140
20	5338	739	439	5341522	0.19	8.476	140

References

1. ASTM C469 C496 C78 C 49 C157 Annu. Book ASTM Stand. Vol. 04.05, 2003 **1980**
2. Al-Ostaz, A. (2008) . Inputs Of Portland Cement Concrete Parameters Needed For The Design of New And Rehabilitated Pavements In, MDOT final report (Report No. FHWA/MS-DOT-RD-07-177)

Acknowledgement

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