AASHO Road Test

Background

The **AASHO Road Test** was a series of experiments carried out by the American Association of State Highway and Transportation Officials to determine how traffic contributed to the deterioration of highway pavements. Officially, the Road Test was "...to study the performance of pavement structures of known thickness under moving loads of known magnitude and frequency." This study, carried out in the late 1950s in Ottawa, Illinois, is frequently quoted as a primary source of experimental data when vehicle wear to highways is considered, for the purposes of road design, vehicle taxation and costing.

The road test consisted of six two-lane loops along the future alignment of Interstate 80. Each lane was subjected to repeated loading by a specific vehicle type and weight. The pavement structure within each loop was varied so that the interaction of vehicle loads and pavement structure could be investigated.

The results from the AASHO road test were used to develop a pavement design guide, first issued in 1961 as the "AASHO Interim Guide for the Design of Rigid and Flexible Pavements", with major updates issued in 1972 and 1993. The 1993 version is still in widespread use in the United States. A new guide, originally planned for release in 2002 but as yet still under development, would be the first AASHTO pavement design guide not primarily based on the results of the AASHO road test.

Test Facilities

Six 2-lane test loops (see Figure 1)
Loop 1 = not subject to traffic, used to test environmental effects
Loops 2 through 6 = subject to traffic described in Figure 2

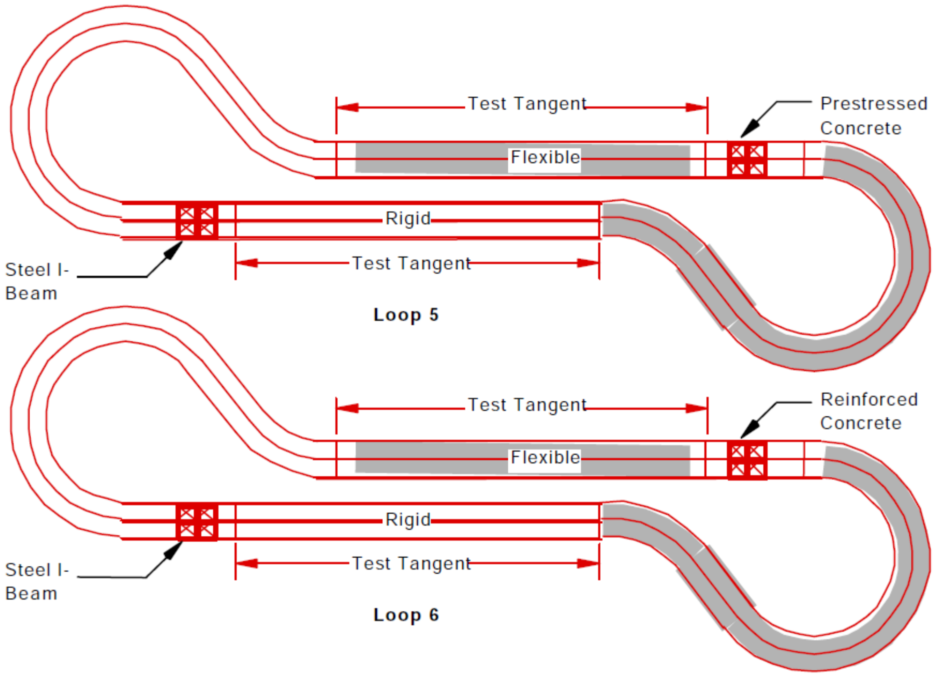


Figure 1: Loop 5 and 6 AASHO Road Test Layout (redrawn from Highway Research Board, 1961)

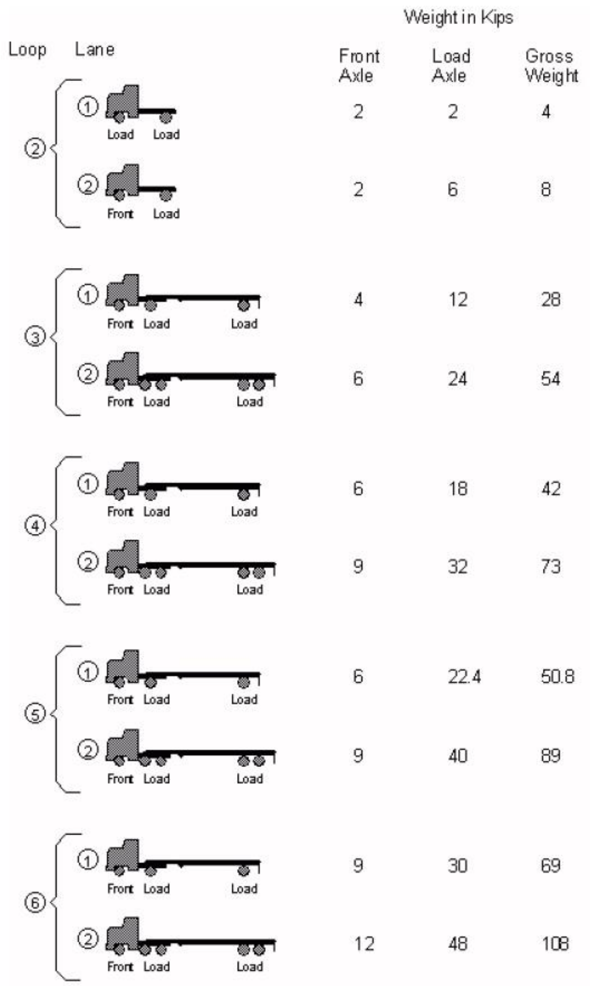
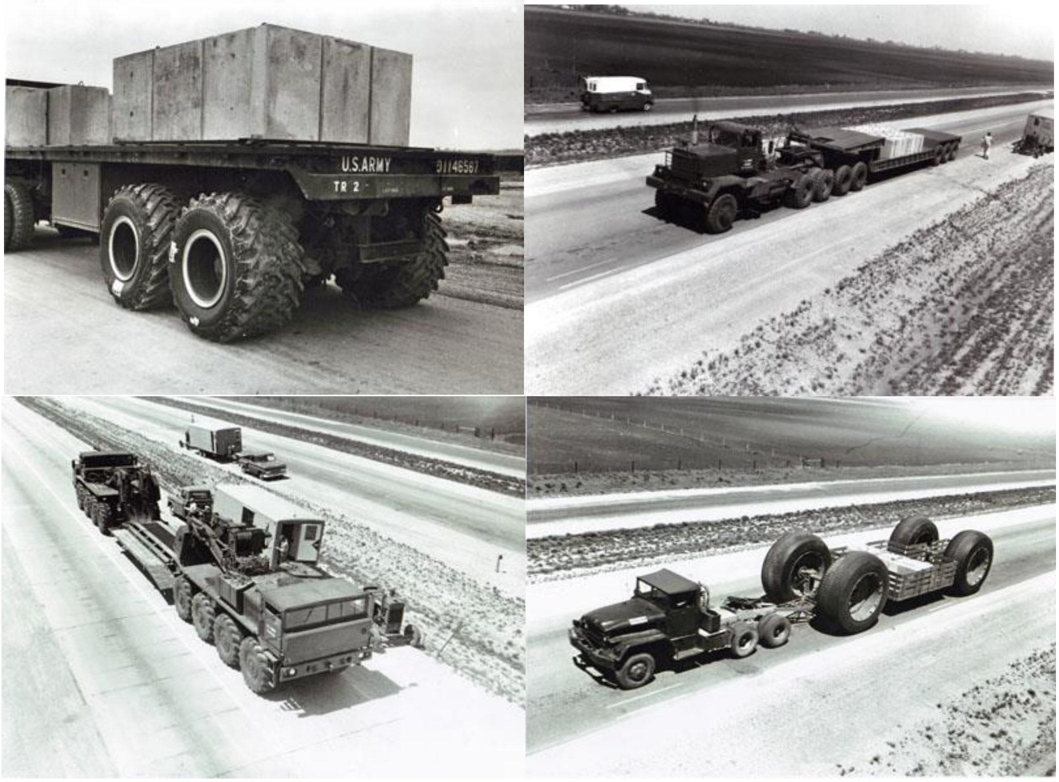


Figure 2: Axle Weights and Distributions Used on Various Loops of the AASHO Road Test (redrawn from Highway Research Board, 1961)



MAJOR TECHNICAL FINDINGS OF THE AASHO ROAD TEST

Surface Thickness
The AASHO Road Test gave quantitative value to the importance of pavement surface thickness in increasing the number of load repetitions that can be carried to pavement failure. It tied pavement surface thickness to pavement performance, where "performance" is defined as the service provided by the pavement or the number of load repetitions that can be carried to an unserviceable level.

Load Equivalency/Damage Factor
Pavement engineers had long had trouble dealing with various axle loads in pavement design. Some methods used only the heaviest load (CBR), and others including the Texas Design Method used the average of the 10 heaviest loads that were expected to be carried on the pavement. The AASHO Road Test provided quantitative information about the relative damaging effect of heavy loads, and immediately after the Road Test, Paul Irick and Frank Scrivner used the Road Test equations to generate load equivalencies called ESALs. Francis Hveem of the California DOT had earlier hypothesized a load equivalency concept tied to 10-kip axles. The Road Test equivalencies validated and extended the Hveem hypothesis statistically. The load equivalency concept (ESAL) is by far the most widely used pavement concept in the world. We as authors have collectively visited more than 50 countries and all 50 states in the United States. All of these agencies use the ESAL concept in pavement design.

PSI: Performance/Serviceability Concept
Before the AASHO Road Test there was no good definition of pavement failure. This seems hard to believe but please check the literature; you will find it to be true. After the WASHO Road Test, Paul Irick and Bill Carey developed the Present Serviceability Index (PSI) concept and defined "performance" as "accumulated traffic to a fixed level of PSI." The selected level of PSI was "failure." While many agencies adopted this concept, some have continued to refer to "roughness." Therefore, a defined level of roughness is sometimes accepted as failure in the form of an International Roughness Index (IRI) level. The technical literature shows that IRI and PSI are inversely related to each other.

The present serviceability concept (PSI) relates pavement failure directly to riding quality and the acceptance or satisfaction of the riding public. It is indeed more definitive of true performance than roughness alone and strong consideration should be given to resurrecting it in pavement studies and designs.

Structural number Concept/Layer Equivalencies: Material Properties
The AASHO Road Test included four types of base under asphalt pavements: (*a*) river gravel, (*b*) cement stabilized, (*c*) asphalt stabilized, and (*d*) crushed stone. These were compared to define the levels of performance that resulted from improving the quality of the base layer. Francis Hveem had also hypothesized such relative benefit of stronger layers as part of a "gravel equivalency concept" and he was instrumental in getting the wedge-shaped base sections added to the Road Test to validate that concept. The structural number concept, developed based on layer equivalencies, is widely used around the world and is the basis for layer selection in all AASHTO Pavement Design Guides up to 2002.

The Road Test of course was not perfect because it was impossible to make it large enough to solve all possible factors. We don't know if these layer equivalencies would be the same with different subgrades and in a different environment. These questions have been the subject of considerable research in the past 50 years.

Value of Subbase to Reduce Pumping in Rigid Pavements
At the Road Test those PCC pavement sections that had a gravel subbase under the slab performed much better than those that were placed directly on the clay subgrade. This occurred regardless of the thickness of the gravel subbase layer. However, there were no stabilized subbases used on the rigid pavements and we can only hypothesize what improvement would have resulted.

Pumping of Subbase and Subgrade Materials
Before the Road Test the PCC paving industry had strongly hypothesized that the problem of pumping of subgrade material from beneath pavements could be solved by placing a granular subbase beneath the slab. This was proved to be incorrect at the Road Test, where under heavy loads and high rainfall, even the gravel subbase layer pumped and caused early slab failure.

Effectiveness of Dowels for Load Transfer
Before 1960 most people were of the opinion that it was necessary to put some form of positive load transfer across joints and cracks in PCC pavements. Yet the concrete industry continued to claim that thicker pavements would solve the problem. The Road Test used load transfer dowels in all pavement sections. There was no faulting at the AASHO Road Test at cracks or joints, thus validating the effectiveness of dowels for load transfer under extremely heavy loads up to 30,000 pounds on a single axle.

Joint Spacing
Two joint spacings were used at the AASHO Road Test: 15-ft joint spacing with no reinforcement steel and 40-ft joint spacing with mild reinforcement. Both of these joint spacings performed well under heavy loads up to 30-kip single axle and both contained dowels across the joints. The 40-ft slabs cracked at approximately 12- to 15-ft spacing, and no faulting occurred at those cracks during the test. However, 15 years later, field studies of some of these same sections left in service on IH 80 did show faulting as the mild reinforcement steel rusted and lost its effectiveness.

Outcomes/Achievement of AASHO Road Test
- Serviceability Concept – PSI
- Traffic Damage Factors – ESALs
- Structural Number Concept – SN
- Empirical Process
- Simplified Pavement Design

Limitations of the AASHO Road Test Findings
Nothing is perfect, and there are several limitations of the AASHO Road Test findings. They are as follows:
1. One subgrade only—the Road Test was carried out on a lean clay subgrade and therefore no direct inference to other subgrades can be made.
2. Only 2 years long—the Road Test was conducted during the period October 1958 to December 1960 and related primarily to this time period and the climatic conditions existing during that period.
3. One environment only—the Road Test took place in Central Illinois, which is a freeze–thaw, wet environment. Information is needed to extend it to other environments.
4. One AC mix only—a single high-quality AC was used in the AASHO Road Test.
5. Information related to other qualities of asphalt concrete surfacing must be inferred in other ways.
6. One PCC mix only—a single high-quality PCC was used in the AASHO Road Test.
7. Information about the performance of other strengths of PCC must be inferred from other sources.