Convergence of Advances in Design, Test Methods and Stabilization Product Technologies

Field Testing

The EMC SQUARED System (EMC2) — Advanced Stabilization Product Technology. Clean. Green. Concentrated power to improve the stability of earth materials at low cost. Applied as compaction water additives to aggregates, soils and recycled pavement materials with pre-established compaction controls and construction procedures, preconditioning aggregate materials to behave more like conglomerate rock, clays like claystone, sands like sandstone, and silts like siltstone, paralleling the natural processes of consolidation and lithification. These stabilizer products have been in use for over three decades for construction of city streets and expressways, county roads, interstate freeways, industrial and renewable energy sites, military supply routes and runways, remote unpaved highways, border roads, haul roads, forest roads, oilfield access roads, temporary and permanent closures of construction sites and landfills, and for other applications.

As with the development of state-of-the-practice Mechanistic-Empirical Pavement Design (M-E Design) Methodology, and the modern repetitive loading laboratory tests, the current advancements in field testing for highway pavements were only made possible with the availability of more recent advancements in computer technology that are required to retain and interpret massive amounts of data in computationally intensive operations. Known as nondestructive tests (NDT), these modern field test methods can evaluate the performance of the pavement and the pavement structural section without the need to damage pavements by coring and extracting samples for laboratory evaluation, which is known as destructive testing. These nondestructive test methods can be conducted relatively quickly and inexpensively to evaluate the stiffness-related parameters (modulus) of the pavement structural section and the condition of the pavement structural section in relation to its ride quality (roughness, or smoothness).

Falling Weight Deflectometer (FWD) and Rolling Weight Deflectometer (RWD)

FWD testing equipment subjects the pavement to a load pulse to simulate the dynamic load produced by a rolling vehicle wheel and then monitors the resulting amount of deflection, or vertical deformation, with sensors that touch the pavement to evaluate the stiffness, or modulus, of the pavement structural section and subgrade. The data can alert reviewers to potential of upcoming pavement failure and requirements for full-depth reconstruction, or the opportunity to increase stiffness of the pavement structural section with the addition of an overlay. FWD equipment is often used during highway research projects to evaluate the performance of materials and stabilizer products used in the base or subbase courses, and the subgrades underneath. As with the Resilient Modulus testing conducted in the materials laboratory, FWD testing measures the stiffness, or modulus, of the materials used to construct the pavement structural section. One of the greatest benefits of using these state-of-the-practice lab and field test methods, when used in conjunction, is that the FWD testing of the constructed pavement structural section can be used to validate the modulus value that the design engineer used as the input for the computations that their Mechanistic-Empirical Pavement Design (M-E Design) program carried out, input that was based upon resilient modulus test results developed in the materials laboratory prior to the pavement design process.

While nondestructive FWD testing is a tremendous advance over destructive test methods, allowing a few miles of highway to be tested at many locations in a single day, using trailer-mounted or van-mounted testing equipment, the test method is still limited in its utility by the need for full stops and equipment set ups at every location, as well as the safety measures necessary to detour traffic around the testing operation. Rolling Weight Deflectometer (RWD) testing equipment has recently been developed to facilitate highway bearing strength testing conducted at highway speeds. Known by its brand name, RAPTOR, with the equipment

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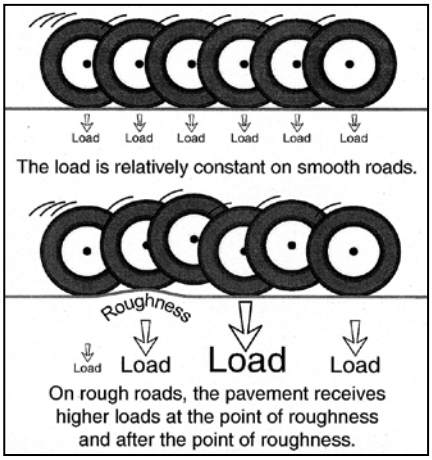
and software developed in Europe by Dynatest, it was first introduced in North American in early 2019, with plans to deploy the operated equipment as a consulting service for rapid evaluation of entire road systems.

While not intended to evaluate pavement stiffness or bearing strength, the following discussion of another nondestructive pavement testing system, which provides pavement performance measurements evaluated according to the International Roughness Index (IRI), is also conducted at highway speeds by van-mounted Road Profiler equipment. As will be further discussed, IRI measurements that are taken annually over decades throughout the United States on the entire National Highway System, and other road systems, are the most significant of all laboratory and field test methods when it comes to evaluation of the performance of stabilized base and subgrade layers. IRI tests evaluate the relative roughness or smoothness of the pavement structural section over time. Since the ultimate goal of the stabilized layers underneath the pavement surface course is to reduce or eliminate differential settlement and roughness over time, advanced stabilization products that promote superior pavement smoothness while increasing the stiffness of the pavement structural section are the most cost-effective option available to pavement design engineers for extending pavement service life.

International Roughness Index (IRI)

The smoothness and ride quality of a freeway, highway, road or city street is more important than most people realize. Why? In addition to reducing the maintenance costs and improving the fuel mileage of the trucks and cars driving on the pavement, the smooth riding or rough riding behavior of the pavement has everything to do with the number of years before it will require major repairs, or complete removal and replacement. Monitoring and measurement of the rate a pavement develops roughness is internationally recognized as the standard method for determining the remaining service life of a specific length of pavement. The federal government's Department of Transportation (U.S. DOT), through its Federal Highway Administration (FHWA), has mandated since 1990 that the Department of Transportation of each state annually evaluate and report on the smoothness of all federally financed freeways, highways and roads within their state boundaries. The measuring system is known as the International Roughness Index (IRI). It provides feedback to the federal government and the states on the quality of each state's design and construction programs in building their paved road networks. Pavement smoothness, as determined by IRI testing, is the functional performance indicator for pavements designed using the AASHTO Mechanistic-Empirical Pavement Design Guide.

Cement, Fly Ash and Lime, the conventional stabilizer chemicals, have been in use since the 1930's in attempts to improve the strength of base course and subgrade layers under highway pavements, but they are costly to apply and of limited effectiveness in controlling localized or differential settlement, which is the primary enemy of pavement durability and smoothness. According to the data that has been produced from the annual IRI field testing provided to FHWA, an advanced stabilization product technology is proving to be far more effective in prolonging the maintenance-free smooth-running performance of asphalt and concrete pavements. These economical concentrated liquid stabilizers, known as the EMC SQUARED® System products, are simply added to the compaction water during the standard procedures used to construct the subgrade and base course layers for asphalt and concrete pavements. This is a case of doing more with less, the essence of sustainable construction. The hyperlinks provided below report on a total of seven highway projects, including two major tollways and four sections of interstate highways located in two different states. Two of these interstate highway projects using the EMC SQUARED System stabilizer products with excellent results were FHWA Demonstration Projects – **http://stabilizationproducts.net/docs/18809.pdf**. These two lengths of pavements were constructed over worst case soil conditions that had previously failed pavements constructed on a layer of cement treated aggregate base course materials. The EMC SQUARED System stabilization treatments of aggregate base and subgrade soils dramatically outperformed cement, lime, and geosynthetic products in reducing pavement maintenance requirements and retaining pavement smoothness. The IRI monitoring data provided by the two state transportation departments reveals the performance advantages of this newer generation stabilization technology that provides superior resiliency and all-weather support for asphalt and concrete pavements. For IRI test results and case histories on 5 additional highway projects, click – **http://stabilizationproducts.net/docs/18468.pdf**.



Pavement roughness leads to higher dynamic loads on localized pavement sections that increases pavement deterioration at those locations. This lowers ride quality and leads to a cycle of increasing deterioration rates and roughness severity.