

# TECHNICAL PERSPECTIVES@ellisassoc.com

## THE VALUE OF A WELL-DESIGNED PAVEMENT

*The state of this country's roadway infrastructure is in a critical condition. In a survey by the Urban Land Institute (ULI) of 30 state transportation-planning directors, 83 percent believe the nation's transportation infrastructure is not capable of meeting the nation's needs over the next ten years. Moreover, they believe that 97 percent of the roads, bridges and tunnels will require at least moderate improvements in the years ahead.*

*Due to rapid growth, maintenance of existing roadways has taken a back seat to the increasing need to construct new roadways to accommodate population growth in areas that were undeveloped. Furthermore, by the time the roadway is built, the traffic impacts on the new road often exceed that for which it was designed which results in pavement failures early in the useful life of the facility. Consequently, a shorter pavement life calls for increased maintenance.*

*The focus of this technical perspective article focuses on the parameters that go into a well-designed pavement section. In doing such, it is important to understand the soil conditions upon which the roadway will be constructed, a reasonable estimate of the expected traffic conditions, and an appreciation of the expected life of the pavement, including planned maintenance intervals, before reconstruction of the pavement section.*

The geotechnical engineering approach that supports pavement section design begins by exploring the subsurface conditions within the planned pavement area, typically referred to as a Roadway Soil Survey. The exploration includes soil borings that are typically spaced at intervals of 100 to 500 feet, alternating left and right of the roadway centerline. The boring intervals vary based on the functional classification of the road and the estimated soil conditions based on review of soil maps and other resources. These borings are supplemented with additional borings or muck probes where soft or organic soils are encountered. The groundwater level is measured at each boring location where the groundwater level is encountered. In some cases, a small-diameter PVC pipe is inserted into the borehole to measure groundwater levels over a period of time. This practice is especially useful when the groundwater level is observed within a layer of low-permeable soils, such as clays. The importance of determining the groundwater profile and estimating the seasonal high groundwater level will be discussed later.

Bulk samples of the subgrade soils are returned to our laboratory for Limerock Bearing Ratio (LBR) tests. The FDOT is moving away from use of the LBR for pavement design towards the Resilient Modulus (M<sub>r</sub>) to characterize soil strength. However, the LBR is still used for local agency and private projects. The LBR values are used to determine the design LBR for the pavement subgrade. The design LBR along with the estimated traffic loadings over the design period determines the required Structural Number for the pavement structure. Using the FDOT-approved coefficients for locally available materials, the most effective pavement design section for both asphaltic concrete and Portland cement concrete surfaces can be identified. During the design process, it is additionally prudent to reference local land development codes for minimum pavement sections based on the facility classification, where applicable.

The soils encountered and sampled during the field exploration are generally classified using the American Association of State Highways and Transportation

Organizations (AASHTO) Soil Classification System. Soils described as sands are classified as A-3 soils. Silty soils are classified as A-2-4 (silty to very silty sands) and A-4 (silts). Clayey soils are classified as A-2-6 (clayey to very clayey sands) and A-6 (clays). Clayey soils that are highly plastic are classified as A-2-7 and A-7. Silty-clayey soils are generally classified as A-2-5 and A-5. Organic soils (peat, muck) are classified as A-8.

The key to a successful pavement design is a strong and well-drained subgrade. Therefore, the most favorable soils are A-3. However, as development encroaches upon wetlands and poorly-drained areas, the soils more frequently encountered are generally silty (A-2-4) and, in some areas, clayey (A-2-6). In addition, borrow sources that contain the cleaner sand soils are becoming scarce. Silty soils can be used as subgrade and fill as they are not as susceptible to losing their strength characteristics with small moisture changes. They should, though, be kept at their optimum moisture content or drier to facilitate placement and compaction. Clayey soils should be avoided as they are very sensitive to moisture changes.

As noted previously, it is important to determine the groundwater profile and estimate the seasonal high groundwater level. One of the primary reasons for early pavement failure is due to wet base and subgrade soils. Estimating the seasonal high groundwater level can be as much an art as it is a science. Proper interpretation of the encountered subsurface soil profile is the primary means of estimating the SHGL. Use of the soil survey maps, published by the Soil Conservation Service, is an important resource for determining historical groundwater levels in primarily undeveloped areas. However, changes in drainage patterns and land use can alter the SHGL. Thus, other factors not specific to soils, such as normal water elevations in adjacent ponds and canals, can influence the performance of pavements.

Once an estimation of the SHGL is established, it is important to design the pavement such that a separation is maintained between the pavement base layer and the SHGL. Typically, this separation should be at least 24 inches. This is to keep subsurface moisture from penetrating the base material, which would adversely affect the life of the pavement. Limerock is a common base material. However, it is sensitive to changes in moisture and will over time lose its strength in wet environments. Less moisture-sensitive bases include aggregate base materials, frequently seen as crushed concrete in northeast Florida, and soil-cement. However, soil-cement is not generally feasible due to the acidic nature of most northeast Florida soils.

In some cases, the recommended separation cannot be maintained. Therefore, underdrains are installed to maintain the groundwater level sufficiently below the base course. Underdrains generally consist of PVC pipe, 4 to 6 inches in diameter, installed 3 feet or so below the pavement surface. They are typically routed to an outfall structure. Where underdrains are installed, it is recommended that a free-draining subgrade soil be used within 2 feet of the base material. This helps to promote drainage of the subgrade to the underdrains. Underdrains are also effective in areas where excessive irrigation occurs adjacent to the pavement, which occurs most frequently in subdivisions.

The success of pavement structures, as with any soil-supported structure, depends on a subgrade that can develop sufficient strength and can effectively drain moisture. The amount of time and money spent exploring the subsurface conditions where the pavement will be constructed will pay for itself many times over in the form of a pavement section that will adequately function for its designed life with regularly scheduled, routine maintenance.