Perpetual asphalt pavements were first developed to meet the extreme needs of high-volume roadways such as interstates and higher-volume state routes. Through careful material selection and pavement design, perpetual pavements can withstand large traffic volumes without experiencing severe problems, such as fatigue cracking and rutting, deep in the structure. This results in a pavement that can easily be rehabilitated at the surface rather than costly deep structural removal and reconstruction.

In recent years, much attention has been placed on perpetual pavements in the context of high volume routes. The Asphalt Pavement Alliance, for example, has recognized numerous roadways through perpetual pavement awards granted to high volume roadways at least 35 years old, having resurfacing intervals of at least 12 years and exhibiting superior performance. Further, many states, such as California, Oklahoma, Wisconsin, Ohio and Kansas are actively designing and building perpetual pavements.

While the focus has been on high volume roadways, the design concepts for a perpetual pavement are equally valid for lower volume roads at the county and municipal levels. This is of particular importance since it is estimated that 86% of the developing world’s road network consists of low-volume roads (1). Further, approximately 69% of U.S. federal-aid road centerline miles have an average daily traffic below 5,000 (2). By ensuring proper design and construction, it would be possible to avoid pavement reconstruction. While traffic delay is not usually an overriding consideration for low volume roads, local businesses and residents will not be inconvenienced if future work is confined to resurfacing the existing pavement structure.

From an economic standpoint, in the U.S., low-volume road maintenance and rehabilitation account for $82,000,000 per year, or about 54% of the annual investment in roads (1). Clearly, low-volume roads are an important part of the worldwide transportation infrastructure and even small improvements in their design can have significant impacts on the economy. Further, Muench et al. (2) investigated the economics of long-life low-volume asphalt pavements in Washington State. According to their research, perpetual pavements for low-volume roads can be 25% more economical than conventional low-volume asphalt pavement design.

To assist engineers in perpetual pavement design, the Asphalt Pavement Alliance sponsored the development of a design program, PerRoad. While the software can accommodate a wide range of conditions (including both low and high-volume roadways), determining the necessary inputs and the time required to execute a design may be too costly and unwarranted for typical low volume roadways. Therefore, a new, streamlined design program was developed called PerRoadLVR, pictured in Figure 1.

PerRoadLVR can be thought of as a simplified version of PerRoad, or a “catalogue” design approach. In developing the LVR version, a large number of design scenarios were considered but were limited to several types of traffic, traffic volumes, soil conditions and asphalt materials. From these design scenarios, simple design equations were developed to determine the required asphalt thickness given the inputs listed above. A full description regarding the development of PerRoadLVR can be found in (3). Within PerRoadLVR, the designer selects the type of traffic from either a rural collector or urban collector. The other traffic inputs include the two-way traffic volume, percent trucks and expected traffic growth. With respect to materials, the designer selects the soil and asphalt stiffness. While specific values may be difficult to obtain for a particular project, the state agency materials office should have representative values available for a variety of materials.
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Within the program, a 4 in. granular base is assumed on top of the subgrade soil. This serves somewhat as a construction platform, in addition to controlling excessive stresses in the subgrade that could lead to deep structural problems over the life of the pavement.

Once the inputs have been selected, the designer clicks the [Calculate] button and the program determines the required asphalt thickness for a 30 year design. Within the program, the design thickness is selected such that the tensile strain at the bottom of the asphalt layer (related to fatigue cracking) and the compressive strain at the top of the subgrade (related to rutting) are controlled within acceptable limits. The result is a pavement that only requires periodic surface rehabilitation.

To demonstrate the program, a number of designs were developed for an urban collector with two soil conditions (stiff and soft) over a range of traffic volumes and an asphalt stiffness of 800,000 psi. The results are summarized in Figure 2 where the influence of increasing traffic is clearly seen. With respect to soil type, about 2.5 inches separated the soft soil from the stiff. While these thicknesses may be greater than traditional low volume road designs, it is important to understand they are designed to a much higher performance threshold requiring minor maintenance rather than deep rehabilitation.

While the current version of PerRoadLVR is effective in designing low volume pavements, there is a need to expand this to various base thicknesses and even lower traffic volumes to make it applicable to a wider range of low volume roads. Work is underway to develop a new release of PerRoadLVR that will consider lower truck percentages and a variety of base thicknesses (not just 4 in.). The current version of PerRoadLVR is available for download. The LCCA software is necessary to operate the LVR. Both are available at http://www.eng.auburn.edu/users/timmdav/Software.html

![Figure 2. Example Low Volume Road Designs](image)

References

