Steps in Designing an asphalt pavement.

A pavement is an integrated system designed to carry traffic from one point to another.

The first step in designing a pavement is to determine what loads the finished system will be required to support.

Traffic loading from cars does not cause much wear and tear on a pavement. Heavy traffic from trucks and busses are what cause a pavement to deteriorate. The measure of this loading is called an "Equivalent Single Axel Load" (ESAL).

1. Traffic

i. **Loads** – Loads can be characterized as: tire loads, axle and tire configurations, load repetition, traffic distribution, and vehicle speed. Quantification can be done in two ways: equivalent single axle loads (ESALs) or load spectra.
   a) **Equivalent Single Axle Loads (ESALs)** – This approach converts wheel loads of various magnitudes and repetitions to an equivalent number of standard loads based on the amount of damage they do the pavement.
   b) **Load Spectra** – This approach characterizes loads directly by number of axles, configuration and weight.

ii. **Growth Rate** – the future increase in traffic volume and wheel loads.

The Asphalt Paving Association of Iowa (APAI) has an easy to use program that will help you calculate ESAL's in their pavement design guide. http://www.i-pave.info/

The program will ask you for some simple traffic data, design/life period (desired pavement life) and growth projections to determine the ESAL count.

Once you know what your pavement will be carrying you can begin to design your pavement.

Building a pavement is much like building any structure. You need to start with the foundation.

2. Soil Support Capability

i. **Subgrade** – The ability of the subgrade to support loads transmitted from the pavement is one of the most important factors in determining a pavement thickness. The pavement system must be designed so the loads transferred to the subgrade are less than the bearing capacity of the native soil to minimize subgrade deformation. Frequently overlooked, the subgrade can often be the defining factor in pavement design.

ii. **Performance** – The subgrade must serve as a working platform to support construction equipment and as a foundation for the pavement structure that supports and distributes traffic loads. This load bearing capacity is affected by degree of compaction, moisture content, and soil type. You want a subgrade that can support a high amount of loading without excessive deformation.

iii. **Soil Classifications** – You'll need to identify the type of soil (sandy, clay, stone, silty clays) as most soils undergo some amount of volume change when exposed to excessive moisture or freezing conditions. Soil can be classified to predict subgrade performance with a few simple tests. The American Association of State and Highway Transportation Officials (AASHTO) classification system for soils is commonly used to determine subgrade-support value. The cost of hiring a geo-technical engineer for soil classification can be more than offset by the savings from an optimized pavement structure design.

iv. **Weak Subgrades**:

a) Remove and Replace with higher quality fill. This can appear expensive up front. When identified at the start of the design process, this can be the most cost-effective strategy.

b) Additional Base Layers can help spread pavement loads over a larger subgrade area. Many engineers are tempted to just design a thick section with more base material simple because the thicker section will satisfy most design equations. However, these equations are at least in part experimental and were usually not intended to be used in extreme cases. In short, a thick pavement structure over a poor subgrade may not make a good pavement.

c) Stabilize the soil with a chemical strengthening agent, asphaltic binder, lime, fly-ash or Portland Cement to increase subgrade stiffness and/or reduce swelling tendencies.

d) Sub-grade stabilization fabrics can be used to develop tension in the sub-base, spreading the load over a wider area.

Each of these strategies has benefits and draw-backs. Schedule, budget and scope of remediation can make each of these approaches more, or less desirable as a solution. You may find that a combination works best for your given challenge.

3. Drainage

i. **General Considerations** –Where is water coming from and where do we need it to go?

Highway engineers recognize the importance of good drainage in the design, construction, and maintenance of any pavement. Proper drainage is important to ensure a high-quality problem-free pavement throughout its service life. Moisture in the subgrade and aggregate base layer can weaken these materials by increasing pore pressure and reducing the materials' resistance to shear. Additionally, some soils expand when wet, causing differential heaving. Moisture in the HMA layers can cause stripping where the moisture will adhere to aggregate particles displacing the asphalt bond. There are two basic categories of drainage – surface and subsurface.

a) **Surface Drainage** – The focus here is on removing water from the pavement surface, shoulder and the adjacent ground. Without good surface drainage this water can pool, infiltrate under the pavement and weaken the subgrade support.

b) **Subsurface Drainage** – The focus here is on removing water in the subbase, the surrounding soil, and in the several pavement courses. This can be achieved with a drainable sub-base material in conjunction with a system of subdrains to remove the infiltrated water.

Inadequate attention to either of these two drainage conditions can lead to premature pavement failure.

4. **Reliability factor -** How long do you want to go with minimum maintenance and how reliable does the pavement need to be. Comes down to cost of lane closure.
5. **Pavement Design –** Now that you know what the pavement must carry, what the soil conditions are and how run-off and subsoil moisture will be handled you can design your pavement structure. The Asphalt Paving Association of Iowa (APAI) has a design program that is suitable for most low traffic applications. http://www.i-pave.info/
    i. This program allows you to fill in your traffic and soil data to determine the optimal pavement design.
    ii. You have the ability to adjust factors for soil stabilization depth of stone base, to achieve the most cost-effective solution for either a PCC or Asphalt pavement.
6. **Material Specifications** – It's recommended that specifications for Asphalt Concrete follow Iowa Department of Transportation Standard Specifications for the class and mixture size required. At LL Pelling we have our own state-of-the-art laboratory and state certified technicians to create unique mix designs for each project and intended use.