

VI. SUB GRADES AND BASES

Articles 2107, 2109, & 2301.10

In the vernacular of pavement design, the word *base* represents the lift of a selected material placed immediately beneath the pavement surfacing. Any selected course of material placed beneath the base is referred to as a *subbase*. The earth grade at the bottom of the pavement structure, whether modified by special treatment or not, is referred to as the *subgrade*.

All of these bases, regardless of placement methods, can be built to acceptable tolerances and provide the working platform necessary to:

- Enhance the quality of performance of the finished product
- Minimize the loss of concrete
- Eliminate short core penalties
- Contribute to value added payment such as smoothness

A. Sub Grade Treatment (Stabilization)

While the bulk of general embankment fill consists of regular Class 10 soil, the upper material in the subgrade directly beneath the pavement structure (subbase, base, pavement) is built of higher quality material. This higher quality soil or material is called 'subgrade treatment' or 'stabilization'.

When necessary, subgrade treatment is used to provide uniform and better support for the subbase, base, and pavement. The type of subgrade treatment used depends on the type, the quality, and quantity of natural soils available on the project. The subgrade treatment material is much stronger than the regular Class 10. However, subgrade treatment should not be used to cover up unstable locations. Thus, it is critical to make sure that the lower Class 10 foundation soil is in reasonable condition before the subgrade treatment is placed, because it may not be economical to later

remove the treatment material for repair of the lower foundation.

Designers will always recommend using on-site soils or borrow for the subgrade treatment, if available, for no other reason than cost of these materials. On site materials are typically on the order of five to ten times cheaper than other subgrade treatment options.

Following are some of the typical materials used as subgrade treatment:

1. Select Soil

Article 2102.04

The normal materials for select backfill are clay loam, loam, or sand. These materials are either granular (predominantly sand) or cohesive (a loam or clay loam which is a good mixture of sand, silt, and clay). Because of the composition and gradation, the density and shear strength are much higher when they are properly compacted.

At locations where modifications were done but stability is questionable, additional select should be considered. This is an economical way to improve stability.

If select sand is used for subgrade treatment, it is often specified in project plans that 3 inches of special backfill be incorporated into the surface. This increases strength and cohesion under construction traffic.

2. Special Backfill

Article 2102.04 and 4132

Special backfill is a uniform mixture of coarse and fine particles of crushed concrete, crushed limestone, composite pavement, or a mixture of gravel, sand, soil; or a mixture of crushed limestone, gravel, sand, and soil. In other words, the special backfill could be a variety of



Clean sand used as select soil



Close up of clean sand select soil

different materials. The requirement for this material is that it has to meet a certain gradation. Since the materials vary, different behaviors should be expected. For example, a piece of rounded gravel is going to provide much less stability than a piece of crushed limestone. In order to get the best material, the inspector may need to work with the contractor to get the better material for each situation. The additional special backfill at questionable locations will certainly improve stability.

3. Polymer Grid

Article 2113

A polymer grid is a high strength polymer material, which is called 'Subgrade Stabilization Material' in Iowa DOT specifications. It is often used in combination with special backfill as an alternative to select backfill when on-site materials are not of sufficient quality to use in the upper part of the subgrade. Polymer grid will then likely be used with special backfill material placed above it.

The open grid structure of polymer grid works better with aggregate base for the interlocking effect. A polymer grid is used by Soils Design for subgrade strength. Grids work because the material has a very high tensile strength which allows wheel loads to be spread over a much larger area rather than having localized punching failure, ruts, etc.

A polymer grid should not be extended beyond the edge of the pavement; otherwise it will interfere with the longitudinal subdrain installation.

Polymer grid is also used to provide additional support at unstable locations of Class 10 foundation



Polymer grid in place prior to spreading of the granular subbase

soils below the subgrade treatment. A polymer grid should be utilized when other methods have been tried but were not successful.

Do not attempt to fix the polymer grid if the stability is not enough. The best thing to do is to add more special backfill on top.

4. Fly Ash Stabilization

Fly ash has been used to stabilize wet or unstable foundation soils beneath the subgrade treatment. In some cases it has been used to stabilize a subgrade treatment of low quality.

Type C fly ash is self-cementing when hydrated, and can be mixed with soil to form a low-grade 'concrete' using soil as aggregate. Fly ash requires moisture for hydration, so addition of fly ash also removes water from wet unstable soils.

A typical mix ratio is 10 to 15% fly ash by dry weight of soil. Water may be added if needed. The mixture must be well pulverized and compacted near optimum moisture. Since setting begins soon after hydration, compaction is done soon after mixing to prevent breakdown of the curing soil-fly ash mixture by compaction equipment.



Spreading the fly ash



Adding water to the fly ash



Mixing the fly ash with the soil



Compacting the fly ash treated material

B. Base and Subbase

Articles 2109, 2111, 2115, 4121, 4123, 4132, & 2301.10

Most agencies specify trimming of the subgrade with electronically controlled trimmers to a specified tolerance prior to any subbase or base construction. The subbase (if specified) and base are then placed to uniform specified depths.

The subgrade is 'proof' rolled no more than one week prior to trimming. Proof rolling is very critical to make sure that the subgrade is strong enough to support the pavement structure. Soft or unstable areas must be reworked to obtain adequate stability. Refer to Article 2109.03.

After being rolled, the subgrade surface shall be at the required elevation.

1. Granular Subbase

Granular subbase will consist of a uniform mixture of granular material placed on a subgrade, uniformly moistened, shaped and compacted.

The main purpose of the granular subbase material is to provide drainage under the pavement. Since this material can have an open gradation, the maximum density often is not very high. In addition, this material is compacted with a maximum of three passes of a self-propelled, non-vibratory steel or pneumatic roller. The compacted density may be from 100 to 120 pcf. Percent voids can be as high as 40%. This is the reason why it is very permeable. Since it is used mainly for drainage, the structural support is also not very high.



Placing granular subbase



Granular subbase in place

Granular subbase is usually specified under Portland cement concrete (PCC) pavement which can provide the bridging support across the granular subbase layer.

Since direct traffic loading on granular subbase can cause degradation of the material and loss of drainability, no construction traffic is allowed on top of the granular subbase layer.

During the construction of the granular subbase, it is very important to check the permeability of this layer. During the trimming process, fines can separate from the larger particles and create thin layers of fines on the surface. Very dry material is most susceptible. The contractor needs to do all that's possible to minimize this problem.

One quick and easy way to check permeability is to fill a one-gallon milk jug with water. Pour this gallon of water from waist level down at one spot. If the water drains away, and there is no sign of any buildup after 30 seconds, the granular subbase layer is considered permeable.

2. Modified Subbase

Special backfill composed of sand and gravel, which is allowed in Section 4132 of Iowa DOT Standard Specifications, may not provide the strength needed to support construction traffic or equipment. A greater percentage of crushed particles and a denser gradation are needed for stability.

Modified subbase is specified in Section 4123 in order to designate a material which will provide stronger support, especially for paving equipment for full-depth asphalt. The



Variability in material due to segregation during trimming



Gravel & crushed gravel as granular subbase



Fine material on the surface due to segregation

specification places a limit of 50% sand and uncrushed gravel content in the mix, as well as includes other specific gradation requirements.

The specification also adds a requirement that the subgrade be proof rolled by a legal axle load before placing the subbase.

3. Special Backfill

Special backfill is used mainly for stability/support. It is normally specified under asphalt cement concrete (ACC) pavement. Type A compaction is required for special backfill. Also, since special backfill is paid by the ton, the contractor usually uses a vibratory steel roller for compaction. This makes the special backfill very strong.

Construction traffic is allowed to run on special backfill. This is one of the reasons why special backfill is specified under ACC pavement so that the asphalt material can be delivered to the paver.

Special backfill is also used under PCC pavement when availability of select backfill is limited, such as in urban reconstruction projects.

Many times the question about drainability of the special backfill is asked. The answer is its permeability can vary because of the differing materials and gradation range allowed for special backfill by specification. It is generally less permeable than granular subbase, but more permeable than most Class 10 or select soil materials, except sand. As a general rule, it is considered permeable enough to require installation of continuous longitudinal subdrains when it is used.



Modified subbase



Certain materials can be used as more than one base type (special backfill & granular subbase)