THE PREPARATION OF SUBGRADES

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Highway engineers recognize that many problems are present in the preparation of the subgrade. This is proven by the various specifications for controlling this item of construction. These specifications generally state that the subgrade shall be thoroughly compacted by approved devices; that all soft or yielding material be removed and replaced by satisfactory material; that grading and rolling shall continue until the subgrade conforms to the required cross section and alignment; that if construction operations create ruts or otherwise damage the subgrade, the required cross section shall be restored by grading and compaction and that no base course material shall be deposited on the subgrade while it is frozen or muddy.

These requirements point out the essential features of subgrade preparation. First, uniformity is emphasized. Requiring the subgrade to be brought to a true grade, cross section and alignment, not permitting ruts or an otherwise damaged subgrade and refusing to allow base course material to be placed while the subgrade is frozen or muddy are definite limits set with the intention of producing uniformity. Second, requiring the subgrade to be thoroughly compacted, and that all soft or yielding material be removed and replaced by satisfactory materials are limits set for control of stability and compaction. Third, a dry subgrade is desired. This is implied by stating that ruts or a damaged subgrade will not be permitted, and that base course material cannot be placed while the subgrade is frozen or muddy. Water control, therefore, is an essential part of the construction process.

Engineers recognize that the quality of the finished surface is dependent upon the subgrade on which the road is built. In other words, any irregularities permitted in the subgrade will be transferred to the surface. This is particularly true with regard to flexible types of pavements.

Specifications have failed in many instances to recognize the nature and condition of the natural subsoil materials. Today a new method of attack is possible. This method is derived from the science of soil mechanics and is applied to highway problems through the means of the soil survey. The presentation and application of soil survey data are accomplished by means of a soil profile and a soil profile report. The soil profile maps and places the natural subsoils into the group classification established by the U. S. Bureau of Public Roads. The soil profile report amplifies data on natural foundation conditions and makes recommendations for design and construction. Knowledge of the nature and condition of the foundation or of the natural material to be used in construction makes it possible to include in the original design the features necessary to insure correct subgrade construction or manipulation.

As speed of construction is often a major requisite it is essential to know in advance the nature of the materials to be used. Making use of this knowledge in the original design can be considered as a notable engineering achievement.

Preparation of a subgrade located in a cut section of road presents an entirely different problem from that present when the subgrade is located on a fill. In cuts the ground water level is nearly always approached, which greatly complicates the problem. In glaciated country, building in cut sections often intensifies the degree of nonuniformity present in the natural subsoil. In fill construction the problem of consolidation is paramount. Nonuniformity in the subgrade of cut sections caused by nonuniformed types of soil or by an excessive amount of water may be corrected by varying the depth of base course or the use of underdrains designed to meet the irregularities and types of soil or conditions present. These measures while not giving uniformity to the subgrade do correct for its nonuniformity and give to the road surface the desired results.

Typical examples in New Hampshire consist of: (1) The construction of gravel bases four feet deep through deposits of uniform fine grained soils, such as silts or clays. (2) The construction of gravel bases 12 to 24 in. in depth through graded soils such as hard pans, glacial tills or cemented soils. (3) The construction of 6 to 12 in. gravel bases through cohesionless soils. (4) The construction of underdrains in the ditch or shoulder line at a depth of 4 to 5 ft. below the finished grade of the road.

Nonuniformity, lack of stability, the presence of muck or peat foundations or the presence of excess water when encountered in fill sections may be corrected to aid proper subgrade preparations as follows:

1. When insufficient time is available for the adjustment of materials used in fill sections or when foundations such as swamp areas are present, construction of high type pavements may be omitted until complete adjustment of the material has been obtained.

2. When rocks must be incorporated in fill sections as an economical feature, definite methods of control should be specified. Limiting the depths of rock layers to 3 ft., requiring jetting or specifying that cohesionless materials be incorporated to insure density are important. A common fallacy in this work has been the tendency to permit the use of tacky materials placed alternately with rock layers. This practice has been dangerous for upon loss of moisture some materials, such as hard pans, may lose their tackiness and a complete readjustment of the fill takes place. The use of cohesionless materials placed in thin layers (6 in. deep) and manipulated by graders or bulldozers has been fairly successful in filling voids in rock fills.

3. When uniform fine grained soils (silts or clays) are used for fills, care must be exercised to limit the depth of the fill in which they are placed. Although these materials may be successfully used in light fills (6 to 10 ft. deep) increasing the depth of the fill beyond these limits may prove dangerous especially with clay soils. Mixing these soils with the coarser grained soils (gravels, sands or graded materials) has added greatly to their stability and made them satisfactory for fill construction to almost any height.

4. Control of the depths of fill layers and the use of proper types of compacting equipment are essential in obtaining the required density on earth fills. In many cases, limiting the depth of the fill layer to 6 in. has proved beneficial. For the uniform fine grained soils, placing the material in 6 in. layers incorporating coarse grained materials and rolling with a sheepsfoot roller or multiple wheel roller has proved satisfactory. For graded soils (hard pans and glacial tills) the same methods are desirable. For cohesionless materials, incorporating binder will increase their stability. In some cases it may be possible under controlled methods to allow traffic to aid in compaction. Traffic compaction is generally desirable. In New Hampshire where soils of the A-4, A-3, or A-2 groups predominate, placing the fill in 12-in. layers and obtaining compaction from traffic, trucks, bulldozers, graders or other equipment working on the fill section have given excellent results.

5. Controlling nonuniformity and lack of stability in fills over swamp areas could be classified as a separate study. Besides the standard practices now used to control this work, such as complete excavation of muck, blasting or jetting of muck areas as fill material is placed; one other method is suggested here which seems worthy of attention. This consists in placing an excessive load on the muck area to obtain quick consolidation. In construction the subgrade of the road may be brought 5 to 10 ft. higher than the finished grade of the road. Under this load the muck is compressed more than it would be by the load which it will finally have to support. Just prior to surface construction the extra fill is evenly distributed over the slopes or at the toes of the slopes. This method has been used to a small extent in New Hampshire. It gives indications of being successful and highly economical.

In applying corrective measures, the important thing appears to be anticipation of conditions needing correction and incorporation of the methods to be used in the original plans and specifications.

Climatic or seasonal conditions also influence subgrade control. The use of frozen materials is particularly detrimental since upon thawing they liberate excessive amounts of water which causes instability and nonuniformity. Uniform fine grained soils (silts or clays) and graded materials (cemented hard pans, high in silt and clay content) which may through dry seasons be satisfactory in producing a stable subgrade may in wet seasons lose stability to a degree that makes them unsatisfactory for subgrade construction. If construction in wet periods is required, the use of a thicker base course has proved beneficial. In New Hampshire these conditions have required the use of as much as 12 in. of gravel to stabilize the subgrade.