APPENDIX E

FIELD CONTROL OF SUBGRADE AND BASE COURSE CONSTRUCTION FOR FROST CONDITIONS

E-1. General. Field control of airfield and highway pavement construction in areas of seasonal freezing should give specific consideration to conditions and materials that will result in detrimental frost action. The contract plans and specifications should require the subgrade preparation work established in this manual in frost areas. They also should provide for special treatments, such as removal of unsuitable materials encountered, with sufficient information included to identify those materials and specify necessary corrective measures. However, construction operations quite frequently expose frost-susceptible conditions at isolated locations of a degree and character not revealed by even the most thorough subsurface exploration program. It is essential, therefore, that personnel assigned to field construction control be alert to recognize situations that require special treatment, whether or not anticipated by the designing agency. They must also be aware of their responsibility for such recognition.

E-2. Subgrade preparation. The subgrade is to be excavated and scarified to a predetermined depth, windrowed and bladed successively to achieve adequate blending, and then relaid and compacted. The purpose of this work is to achieve a high degree of uniformity of the soil conditions by mixing stratified soils, eliminating isolated pockets of soil of higher or lower frost-susceptibility, and blending the various types of soils into a single, relatively homogeneous mass. It is not intended to eliminate from the subgrade those soils in which detrimental frost action will occur, but to produce a subgrade of uniform frost-susceptibility and thus create conditions tending to make both surface heave and subgrade thaw-weakening as uniform as possible over the paved area. The construction inspection personnel should be alert to verify that the processing of the subgrade will yield uniform soil conditions throughout the section. To achieve uniformity in some cases, it will be necessary to remove highly frost-susceptible soils or soils of low frost-susceptibility. In that case the pockets of soil to be removed should be excavated to the full depth of frost penetration and replaced with material of the same type as the surrounding soil.

a. A second, highly critical condition requiring the rigorous attention of inspection personnel is the presence of cobbles or boulders in the subgrades. All stones larger than about 6 inches in diameter should be removed from fill materials for the full depth of frost penetration, either at the source or as the material is spread in the embankments. Any such large stones exposed during the subgrade preparation work also must be removed, down to the full depth to which subgrade preparation is required. Failure to remove stones or large roots can result in increasingly severe pavement roughness as the

stones or roots are heaved gradually upward toward the pavement surface. They eventually break through the surface in extreme cases, necessitating complete reconstruction.

b. Abrupt changes in soil conditions must not be permitted. Where the subgrade changes from a cut to a fill section, a wedge of subgrade soil in the cut section with the dimensions shown in figure 7-1 should be removed and replaced with fill material. Tapered transitions also are needed at culverts beneath paved areas (fig 7-3), but in such cases, the transition material should be clean, non-frost-susceptible granular fill. Other under-pavement pipes should be similarly treated, and perforated-pipe underdrains should be constructed as shown in figure 7-2. These and any other discontinuities in subgrade conditions require the carefullest attention of construction inspection personnel, as failure to enforce strict compliance with the requirements for transitions may result in serious pavement distress.

c. Careful attention should be given to wet areas in the subgrade, and special drainage measures should be installed as required. The need for such measures arises most frequently in road construction, where it may be necessary to provide intercepting drains to prevent infiltration into the subgrade from higher ground adjacent to the road.

d. In areas where rock excavation is required, the character of the rock and seepage conditions should be considered. In any case, the excavations should be made so that positive transverse drainage is provided, and so that no pockets are left on the rock surface that will permit ponding of water within the depth of freezing. The irregular ground water availability created by such conditions may result in markedly irregular heaving under freezing conditions. It may be necessary to fill drainage pockets with lean concrete. At intersections of fills with rock cuts, the tapered transitions mentioned above and shown in figure 7-1 are essential. Rock subgrades where large quantities of seepage are involved should be blanketed with a highly pervious material to permit the escape of water. Frequently, the fractures and joints in the rock contain frost-susceptible soils. These materials should be cleaned out of the joints to the depth of frost penetration and replaced with non-frost-susceptible material. If this is impractical, it may be necessary to remove the rock to the full depth of frost penetration.

e. An alternative method of treatment of rock subgrades--in-place fragmentation--has been used effectively in road construction. Blast holes 3 to 6 feet deep are commonly used. They are spaced suitably for achieving thorough fragmentation of the rock to permit effective drainage of water through the shattered rock and out of the zone of freezing in the subgrade. A tapered transition should be provided between the shattered rock cut and the adjacent fill.

E-3. Base course construction. Where the available base course materials are well within the limiting percentages of fine material set forth in chapter 5 of this manual, the base course construction control should be in accordance with normal practice. In instances where the material selected for use in the top 50 percent of the total thickness of granular unbound base is borderline with respect to percentage of fine material passing the No. 200 sieve, or is of borderline frost-susceptibility (usually materials having 1-1/2 to 3 percent of grains finer than 0.02 millimeters by weight), frequent gradation checks should be made to insure that the materials meet the design criteria. If it is necessary for the contractor to be selective in the pit in order to obtain suitable materials, his operations should be inspected at the pit. It is more feasible to reject unsuitable material at the source when large volumes of base course are being placed. It may be desirable to stipulate thorough mixing at the pit and, if necessary, stockpiling, mixing in windrows, and spreading the material in compacted thin lifts in order to insure uniformity. Complete surface stripping of pits should be enforced to prevent mixing of detrimental fine soil particles or lumps in the base material.

a. The gradation of materials taken from the base after compaction, such as density test specimens, should be determined frequently, particularly at the start of the job, to learn whether or not fines are being manufactured in the base under the passage of the base course compaction equipment. For base course materials exhibiting possibly serious degradation characteristics, construction of a test embankment may be warranted to study the manufacture of fines under the proposed or other compaction efforts. Mixing of base course materials with frost-susceptible subgrade soils should be avoided by making certain that the subgrade is properly graded and compacted prior to placement of base course, by insuring that the first layer of base course filters out subgrade fines under traffic, and by eliminating the kneading caused by overcompaction or insufficient thickness of the first layer of base course. Experience has shown that excessive rutting by hauling equipment tends to cause mixing of subgrade and base materials. This can be greatly minimized by frequent rerouting of material-hauling equipment.

b. After completion of each course of base, a careful visual inspection should be made before permitting additional material placement to insure that areas with high percentages of fines are not present. In many instances these areas may be recognized both by examination of the materials and by observation of their action under compaction equipment, particularly when the materials are wet. The materials in any areas that do not meet the requirements of the specifications, which will reflect the requirements of this manual, should be removed and replaced with suitable material. A leveling course of fine-grained material should not be used as a construction expedient to choke open-graded base courses, to establish fine grade, or to prevent overrun of concrete. Since the base course receives high

stresses from traffic, this prohibition is essential to minimize weakening during the frost-melting period. Action should be taken to vary the base course thickness so as to provide transition, when this is necessary, to avoid abrupt changes in pavement supporting conditions.