



## CHAPTER VI PAVEMENT STRUCTURE DESIGN

### SECTION 6-02

### UNDERDRAINS

**6-02.1 GENERAL.** The presence of moisture or water within or beneath the pavement structure is almost always detrimental to some degree, depending upon many variables including pavement, base and soil characteristics, degree of saturation, the extent and range of moisture fluctuations over time as well as temperature variations. For example, water affects various subgrade soils in differing ways. A granular soil may consolidate or settle in the presence of water, particularly when subjected to traffic vibrations, and may lose little or even gain in subgrade support. A clay soil on the other hand will soften with increasing moisture content and, depending upon initial density and restraining load, may swell significantly resulting in both pavement heave and loss of support. Silty soils are especially prone to capillary movement of water, to frost heave, and to pumping when saturated and subjected to dynamic stresses from traffic.

Subsurface water may have a number of sources although ultimately all originates from rainfall. Subsurface water has been classified as *gravitational or free water*, which can be more readily drained by cuts or by interception drains, and as *capillary water* which is little influenced by such measures and is best controlled by a blanket or porous, free draining material which breaks the capillary path. Water may also move by *vapor phase* from a relatively warm subgrade to condense on the bottom of a cold pavement slab, for example. Experience has also shown that much of the water affecting the pavement structure originates as surface water which enters through joints and cracks and that such water eventually develops free-flow channels in relatively impermeable dense graded bases, particularly along and beneath the pavement-shoulder joint, leading to softening and loss of support at the edge of the pavement.

Most subgrade soils experience an increase in moisture content after paving, as do low permeability, dense graded bases. Other (mostly seasonal) variables aside, a degree of moisture equilibrium is usually reached within a few years, at which time many formerly smooth pavements may reflect both differential settlement and swell. Long-lasting, smooth pavements can be achieved, however, by conscientious efforts to provide *uniform*, (not necessarily high) subgrade support and by providing the maximum possible degree of drainage for the pavement and base.

#### 6-02.2 TYPES OF UNDERDRAINS

**6-02.2 (1) PIPE-AGGREGATE UNDERDRAINS.** Pipe-aggregate underdrains consist of a geotextile lined trench, perforated plastic or metal pipe, and porous backfill. Functionally, these may be installed either as interception drains to capture localized sources of water, or as pavement edge drains to drain permeable base courses on new construction.

**6-02.2 (2) FRENCH UNDERDRAINS.** French underdrains consist of fabric wrapped, coarse porous backfill in a trenched installation. No pipe is used except for a short length of metal pipe as an outlet. Functionally, this is an interception type drain.

**6-02.2 (3) GEOCOMPOSITE PAVEMENT EDGE DRAINS.** Geocomposite pavement edge drains consist of a geotextile wrapped plastic core or drainage medium which is installed in a narrow trench along the edge of pavements being rehabilitated which meet certain criteria.

**6.02.3 LOCATION AND USE OF UNDERDRAINS.** The movement of moisture in soil and rock strata can be very complex and is influenced by the seasons, surface topography, vegetation, the configuration of subsurface soil and rock profiles and the relative degrees of permeability of the various layers, as well as animal burrows, root holes, and the activities of man (utility trenches, well, ponds, and lakes, etc.). Accordingly, it should be recognized that it is extremely difficult, if not impossible, to determine all of the possible locations requiring drainage during the design stage of roadway plans. These sources will, in some instances, be determined during the soil survey or during design field checks. Many times, however, these sources are missed entirely because the source may be small, or because the soil surveys are made during dry periods when these sources may not be evident. In many instances, only a careful inspection of conditions existing during construction will reveal sources of water which may cause

detrimental effects on the roadway and which should be drained. The use of underdrains or other methods should be determined by the engineer after examination of the site and consultation with the district soils and geology technologist.

It is also entirely possible that locations for underdrains may be specified which will prove to be unnecessary. In any case, details for underdrains required for known conditions, other than those shown on the standard plans, are shown on the design plans based on the best information available at the time the plans are prepared.

Pavement edge drains are required for new rigid or flexible pavements on medium and heavy duty routes, and permeable base courses will be provided on all heavy duty pavements with the following exceptions. Pavement edge drains and permeable base courses are not required where a minimum of 2 ft. [0.6 m] of daylighted rock base can be furnished for the top of the subgrade or where hydraulically placed sand fill comprises the top 4 ft. [1.2 m] of the embankment with not more than 2 ft. [0.6 m] of soil cap on the slopes. Thin courses of permeable bases cannot be relied upon to provide permanent drainage when daylighted and should never be used without longitudinal edge drains

All new rigid and flexible pavements, light, medium, or heavy duty, are to be provided with 2 ft. [0.6 m] of rock base in the top of the subgrade whenever available in suitable quantities on or in close proximity to the job.

Interception underdrains are designed with a minimum fall of at least one and preferably 2 percent or more and an outlet at least 6 in. [150 mm] and preferably 12 in. [300 mm] above the ditch flow line. The underdrains are skewed to obtain the necessary fall and clearance. The roadway ditch should be deepened to meet these requirements if necessary. Longitudinal underdrains are designed with flow lines paralleling the pavement and base grades and with outlets on their respective side of the pavement unless it is absolute necessary to carry the water beneath the pavement to an outlet. See [Subsection 6-05.3](#) for details concerning outlet location and spacing.