CHAPTER 29
MOUNTAIN ROADS AND TRACKS
SECTION 136-DRAINAGE

2901. **General.** The drainage plan is the most important problem in mountain road design. Control of water throughout the working area is vital at all stages of construction to maintain subgrade condition and prevent silting up or damage by scour.

Design

2902. General principles are given in Chapter 5, but calculations must be based on the worst storm conditions likely to be based on the worst storm conditions likely to ne experienced Snowmelt from high ground during the spring thaw must be considered.

2903. In broken country drainage characteristics varyconsiderably in different areas when calculating the run off tone handled divide the alignment into appropriate sectors never more than 2000yards long.

2904. The total area of waterway to be provided in culverts can be worked out from the calculated run off, or be read from table 5.2, but this quantity will relate only to the discharge of storm water falling on the uphill drainage area. If there is ever any fair weather flow in watercourses crossing the alignment, the waterway required for this volume of water must be provided in addition.

2905. In the absence of hydrological data, likely conditions can be assessed roughly from:

a. Information from local inhabitants.
b. Personal observation.
c. Survey of existing watercourses (see para 105).

2906. A mountain stream carrying a trickle of water in fine weather may become a torrent after a storm. Look for high water marks, signs of scour, debris thrown up by flood water. Boulders lying in the bed of a stream are a certain sign of spates.
Culverts

2907. **Siting.** Correct siting and setting out are important, to prevent ponding and scour. The main practical 1 difficulty are the large number of transfer points that may be needed the steep transverse slopes often involved, and the out cropping of rock on the uphill side of the road. As a principle, transfer of relief points should be provided:

a. At every natural watercourse, including inconspicuous gullies.
b. In every re-entrant.
c. At the uphill end of every sharp bend, i.e. at the tangent point.
d. At intermediate points, as required to relieve catch water ditches and side drains.

2908. **Priority.** Build culverts as early as possible, to dispose of water from catch water ditches before the subgrade is exposed (see para 824).

2909. **Design.** (see Section 132) Invert level should coincide with the natural slope of the watercourse introduced; scour aprons are normally required at both intake and outlet sides; and adequate catch pits should always be provided at the intake.

Precast concrete pipes reduce construction time and save skilled labor, but their transport may be extremely difficult in the early stages of road construction.

Drainage Ditches

2910. **Catchwater Drains.** These must be treated as a priority task (see para 700). Layout and construction are dealt with in Section 68.

2911. **Side Drains.** (see Section 67) Mountain roads are often largely in side-hill cut, with one side drain only on the inner side of the road. Common constructional faults, which may lead to road failure in severe storms are:

a. Insufficient waterway area.
b. Sides too steep.
c. Gradient too steep.
d. Insufficient clearance between edge of carriageway and edge of ditch.
e. Insufficient berm between edge of ditch and toe of bank.

Irish bridge and causeways

2912. Irish bridges (see Section 133). Culverts should always be used on all-weather roads, but Irish bridges may have to be accepted, at least temporarily on hastily built roads.

2913. Causeways. Causeways often have to be used instead of high level bridge, specially over very wide and flat water-courses which are dry except after storms. Very careful design of the waterway through them is essential (see para 776).
Temporary hill tracks.

2914. Whenever possible the surface of any track in side hill cut should slope inwards to a side drain, from which water is discharged either by culverts or over Irish bridges. For very hasty work on tracks for $\frac{1}{4}$ ton trucks or pack animals, time and labor will be saved by giving the surface a till outwards, at a slope of in 15 to 1 in 20, but such tracks soon become dangerous in wet weather.

On long, steep slope heavy rain wil cut channels is down the middle of an unsurfaced track unless water is diverted over the edge, or into the inner drain, as the case may be. For this purpose, projecting ridges of stone or timber (‘pankttas’’) should be set across the track at an angle of 45^{o} A rough rule for spacing is based on the square of the gradient e.g. 100 ft apart on a slope of 1 in 10.