Some General Hints on the Making of Forest Roads.

By A. FLANAGAN

WHILE many of the ideas in the following contribution were taken from literature on road construction the writer has had practical experience of all the operations mentioned, gained in supervising the making of seven miles of roads at Galtee Forest, Co. Tipperary.

The planning of a good road system is essential to good forest management. As well as serving for extraction purposes, roads also serve ideally as internal fire-belts. For the latter purpose the network should be planned if possible at the time of planting, and preliminary work should be done at the first chance available. Good forest roads enable us to reach a fire more quickly by car or other transport, thus helping to prevent considerable damage. They may also be used to much advantage as inspection paths as by their dividing the forest into separate blocks, the forester becomes more thoroughly acquainted with parts of the forest he might seldom otherwise be able to see.

Gradient, haulage distance and the proximity of suitable metalling material are the most important factors to be taken into consideration when planning a road system. The following factors will, however, also have an important bearing on the cost of construction :—the width of the road to be made, the number of bridges to be constructed, the number of gorges to be filled and V bends to be built up, the depth of the banks to be cut through, the number of culverts to be made, and the quantity of boulders or large roots to be blasted or removed.

Road Density.

The correct road density is a much debated subject, but many are of the opinion that the most economical haulage distance to forest roads is 150-200 yards. Unfortunately most of our forests are on hilly ground, which only permits of one-way haulage, i.e. downhill. This means that most of our roads will be 150-200 yards apart depending on the slope of the ground. If the slope is very steep it may be necessary to have roads as close as 150 yards apart. If the forest is on level ground a two-way haulage system is possible, which means that roads will serve for extraction at 300-400 yards apart. In this way forest roads are a more economical proposition on level ground.

Ascertaining Gradients.

The use of T squares is one of the simplest methods of ascertaining gradients. Two T squares should be used, and a short plumb line should be affixed to each, the plumb line to hang directly from the centre of the horizontal bar of the T. The leg of each T should be 5 ft. long and the horizontal bar 1 ft., the leg being split from top to bottom with a pencil line. To ensure that the T is standing correctly vertical, the plum line should coincide with this pencil line, and to make certain that the T is not leaning forwards or backwards, the plumb line should also hang just touching the leg of the T. One T should be held on the lowest point of the road, while the other is held on higher ground, for example, 20 ft. apart. On sighting the lower T against the higher one, the higher T should be marked where the line of vision meets it. Measure the distance from this to the top of the T and you will get the gradient in 20 ft. When planning the road site the higher T can be moved to suit the gradient required. By moving the Ts in alternating positions, gaining height as required, a road can easily be sited. The general opinion is that the maximum gradient may be as much as 1 in 10, but some steep inclines may be as much as 1 in 8, while other parts of the road may have very little gradient.

Aligning the Road.

Before any preliminary work is commenced, the road alignment should be marked out. It is very essential to walk the ground several times in order to become fully acquainted with the prospective site and any difficulties that may arise, and to have a definite point to be reached previously marked out. Short stakes should be driven into the ground about 20 ft. apart, and with the aid of the T squares the best and most suitable gradient should be obtained. For cross-sloping ground the tops of the stakes will mark the road for preliminary work, and no excavation should be done under this level as it would be unnecessary work. Poles should now be used to mark the upper and lower sides of the road. Where heavy excavation has to be done, an allowance should be made for this when placing the poles, so that the material excavated can be used to give a foundation of the required width. For example, the poles on the upper side of the road may be placed 5 ft. above the levelling stakes, and the poles on the lower side 8 ft. below the levelling stakes, depending on the depth of excavation to be done.

Road Widths.

Experts are not always in agreement on the most suitable widths for forest roads, but in the writer's opinion an overall width of 13 ft., seems suitable, while the metalled width need not be more than 9 to 10 ft. A margin of 2 ft. should be left outside the metalled surface. No special water channel need be constructed on the other side if the road is cambered and the ground is hard. Where steep banks are cut

through, they should be sloped to an angle of 60° to prevent material loosening and filling the side drain. The crown of the road should be the highest point when complete, being about 2″-3″ higher in the centre than at the sides. Banks of soil should not be left on either side as these would hold surface water on the road, and where steep gradients are concerned may cause heavy erosion on the metalled surface.

Material.

The procuring of suitable material presents a big problem in road making. The amount of material required, depends on the type of ground to be roaded. If the ground is hilly there will be the problem of filling or bridging large ravines and deep hollows and the building of V bends, all of which use a large amount of stones and gravel. The finding of rock and deep layers of gravel on this type of ground is not unusual, particularly in Old Red Sandstone areas, when preliminary work is being done. Often there is found a good solid foundation, that needs no metalling, and which makes a very good road surface. The gravel found on this type of ground is ideal surfacing material. Such material is frequently found where heavy excavation has to be done, and, being on the site, helps to cut the cost.

Metalling.

If paving is considered necessary, it is best done by placing the stones closely together on edge, and then "blinding" with smaller stones. All points that require revetment, such as at the crossing of ravines, deep hollows and at V bends, should be built at an angle of 60° inwards, to ensure that no sliding occurs. Likewise where soil banks have to be made, they should also be sloped at an angle of 60°. After "blinding" with small stones, the surface should then be covered with 2″-3″ of coarse gravel, a slightly clayey gravel giving the best binding surface. It generally takes a month for the surface to become consolidated and during this period compaction of the material should be helped by traffic. After this all loose stones should be picked, to produce as smooth a surface as possible.

Bridge and Culvert Construction.

The building of bridges and culverts needs careful planning and construction. Concrete pipes should be used as much as possible, but the erection of bridges will be necessary in some cases. Where pipes are used they should be encased in 1 ft. of material free from big stones such as fine gravel or soil. The object of having the material fine is the better distribution of the load so as to prevent the pipes from cracking. The inlet jaws should be built with stone to prevent erosion on either side of the bank. The bottom of the inlet should also be paved with stone to a distance of about 6 ft. out from the inlet, in order to prevent erosion under the pipes. The retaining walls

and both ends of the pipes should be pointed with cement mortar particularly at the inlet to make certain that there will be no damage done by water. The pipes should be allowed to carry a covering overhead of at least 1 ft. more than the diameter of themselves, for instance a 3 ft. pipe would need 4 ft. of covering. The maximum depth of water they should be required to carry should not exceed $\frac{1}{3}$ of the diameter of the pipe so as to ensure that no choking occurs.

Where the gradient is steep, it will be necessary to lay culverts at intervals of about 50 yards to lessen the water flow on the roadside and prevent erosion. This applies particularly where high banks have been cut through in which case a heavy flow of water may undermine the bank. When constructing culverts it is advisable to have the outlet 6 ins. lower than the inlet, as this will prevent them from becoming choked with washed material.

In the construction of large culverts, double and triple rows of 3 ft. pipes can be used and the covering material and retaining walls can be similar to those used in single-row culverts. Where bridges are substituted, either concrete or wooden ones may be built, but the concrete ones may prove cheaper and better in the end.

It may be argued that forest roads are very costly, but when it is considered that with light repairs now and again, they will serve several rotations, they should more than repay their cost.