ROAD CONSTRUCTION AT GLENDALOUGH STATE FOREST

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In this short article it is hoped to give some account of the many difficulties, the many interesting problems met with and surmounted during a short period of road and bridge construction at Glendalough State Forest.

For those who do not know Glendalough it is necessary to describe briefly the peculiar topography, due geologically to the over-deepening of a pre-existing valley by local glaciation at the end of the Ice Age. This resulted in a comparatively narrow, steep-sided glen, gouged out of the rock to a depth of some 300 feet below the original level. It extends in elevation from 450 to 1,000 feet, with often a slope of 1 in 2 (1 foot rise for every 2 feet horizontally) and occupies only a very limited area. Above this are comparatively gentle slopes. rising to 2,000 feet, on which exists the bulk of the forest property of Lugduff and Derrybawn, which the road system was intended to serve.

The problem, it will be seen, was to make accessible the considerable area of young plantations on these upper slopes by negotiating as directly as possible the steep glenside with a graded motor road. The only possible road site was the old zig-zag cart road, cut through schist soil and rock, on Derrybawn, near Poolanass waterfall. It climbed in traverse arms steadily and steeply, with an average gradient of 1 in 7, and, though only serving in itself this limited area, it was the gateway, the main artery, to the upper slopes.

To make usable this old cart track for lorry traffic, three things required to be done :—

1. Widening of track to 12′ by cutting into slope.
2. Substituting curves for sharp angles at turning points.
3. Easing of gradient at bends and superelevation.

Except for the blasting of some rock, the widening did not present any great difficulty. Special attention had to be given to the question of turning points.

Turns.

Two of the turns on the zig-zag track were marked by eye, while the remainder were marked by using the method outlined below. See Fig 1. In using this practical method of setting out a curve, the choice of radius must be made on the ground available for turning and the starting point must be obtained by trial and—possibly—error. Text books usually specify 50′ as optimum radius, but in really difficult ground such as this, radii of 30′ and slightly less had to be used. Incidentally it should be remembered that the radius refers to the centre and not to the margins of the road.

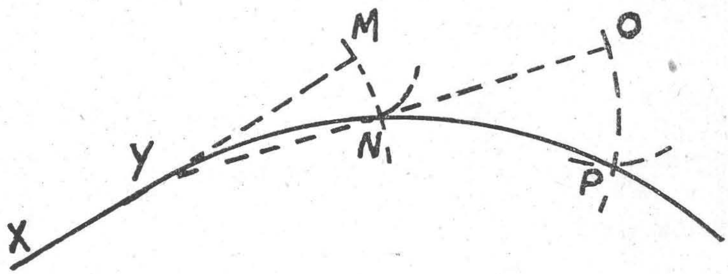

Fig I

For a curve of 50′ radius and starting point Y on road X.Y., proceed as follows. With Y as centre and 25′ radius describe an arc passing through M, a point in line with X.Y. With M as centre and 6¼′ radius describe an arc cutting the previous arc at the point N. This is the first point in the curve. Now, with N as centre and 25′ radius describe an arc passing through the point O in line with the chord Y.N. With O as centre and 12½′ radius describe an arc cutting the previous arc at the point P. This is the second point in the curve. To complete continue as above, using 12½′ offset, and ease off to the other road arm. The above practical method is based on this simple rule for forming a circle:— "The offset is to the chord as the chord is to the radius." For a road curve the first offset will be half the normal offset being taken from a tangent and not a chord.

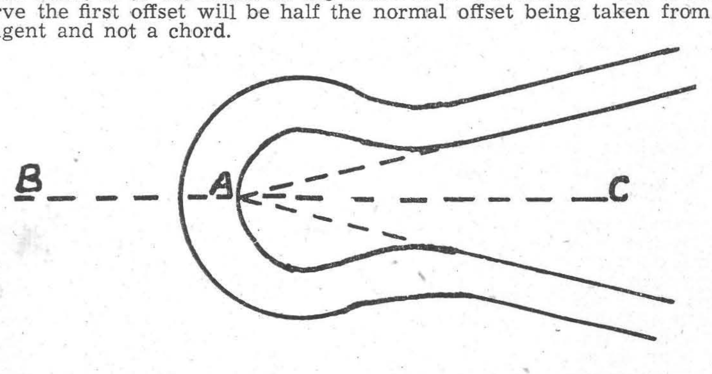

Fig II.

The use of this straighforward method on the zig-zag turns led to complications on account of the acute angle between the meeting road arms, and the steep gradient of the bend. In fact it was found necessary to use a turn of the type illustrated in Fig. II. In this turn the straight road arms approach one another closely, and then diverge in a wide sweep. the inner margin of the bend being around the intersection of the produced road arms. In this type the curve gradient need not be greater than the gradient of the road arms. The further from the point A along the line A.C. that the curve is marked, the greater the curve gradient and, conversely, the further out from the point A along the line A.B. it is marked, the easier the curve gradient, until a point is reached when it is practically level. See Fig II. To ease the curve gradient of curves along A.C. and to eliminate a common fault, i.e., an oversteep turn higher on the inside than the outside, the gradient of the upper and lower arms must be increased to an undesirable and impractical degree and at great expense. Bends, to be of practical value on a zig-zag like Glendalough, must be marked out along the line A.B. where the easing of gradient, if required. may be accomplished by only slightly increasing the gradient to and from.

Superelevation :—Is the inward canting of a bend and is formed by elevating the outer edge above the inner edge. This counteracts the centrifugal force which tends to swing a lorry outwards when negotiating a bend, by the inner displacement of the centre of gravity of the lorry. The degree of superelevation will depend on the radius of the turn ; the smaller the radius, the greater the superelevation required.

Embankments.

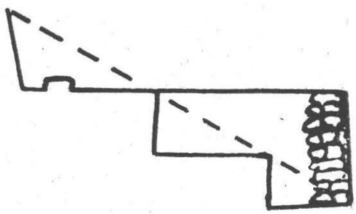

Fig III

Having marked out the proposed site of bend or straight road on steep slope where building of embankment was necessary, the slope was levelled in steps (or terraced) to the required foundation height ; the width and depth of steps depending on gradient of slope. The first step should protrude beyond the proposed outer edge of the road a distance great enough to ensure gentle sloping of embankments and approximately 2′ margin between edge of embankment top and road (see Fig. III.). Low embankments were built with soil and rubble, well tamped in shallow layers by a workman shuffling over the surface and at each shuffle pressing heavily with his feet. To stabilise and retain the embankment on steeper slopes a revetment wall was added. This wall was built with large stones, the foundation stones being embedded at right angles to the incline of wall, i.e., sloping inwards, and each course was placed approximately 2 inches inside the preceding course. This should be impressed on workmen as they tend to build perpendicularly. Large roots and boulders were not used as far as possible through the soil and rubble, as this would tend towards uneven settling of foundation. On gley and peaty areas a closely-packed layer of conifer prunings was laid on the surface before building commenced. Boning rods are most useful for finding the required depth of building.

Drains and Culverts.

On steep slopes and in districts of high rainfall, preparation of road site without at the same time making ample provision for a drain on the upper side, and for sufficient culverts, is merely a waste of time and money. The absence of drains results in the sweeping away of road metalling, and sometimes even of soling and foundation. On the other hand, the presence of drains without making ample provision for leading-off of flow by use of culverts will result in severe undermining of road in a short time. One flood will be quite sufficient. When marking out the road ample width was allowed, where possible, for a drain on the upper side. This was levelled 6″ above the road foundation and then the drain marked and sunk, leaving a bank about 1′ wide between road and drain. (See Fig. III.).

The culverts were placed at varying distances apart, depending on the topography and road gradient. Complementary culverts were also built just above and below the zig-zag bends, which ensured easy run-off of water and saved bends from being undermined. Water from some of the culverts on the zig-zag flowed to lower arms of the road causing severe cutting of the drains. To carry this water away from the lower road or to direct it to a culvert, contour drains had to be sunk. To avoid severe undermining and cutting of these contour drains during high flood period, they were marked out some distance below the culverts so that the water from the culverts could enter them as surface water. The actual building of the culverts, 9″ square, was simple, well-faced stones and "flags" being available. Oak or larch poles could also be used instead of "flags" for covering, but this is not so satisfactory. The "flags" or poles should not be higher than the level of the road foundation, as the soling and metalling absorb the shock and distribute the weight of the passing load. All culverts were built at right angles to the road and had only slight fall to prevent undercutting.

Soling and Metalling.

Having prepared the levelled, graded foundation as above, the final steps were soling and metalling. The former consists of a layer of large stones (6″ approximately) which, in County Council work, are simply spread and rolled in. As a steam roller was not available for forest work, it was necessary to pack the stones closely by hand. The stones available—mainly schist slabs—were rather flat, and they had to be built standing vertically, so that when subjected to load they would bind tightly. If laid flat they tend to rock and remain loose. On one section where, during a rush period, the stones were not so laid, rutting has become very troublesome. Ideally, the soling should not come in contact with the wheels, but should be permanently protected by a layer of smaller stones—the metalling. Hard rock, i.e., silurian and quartzite, were used for this layer as far as possible, but unfortunately, owing to scarcity, long haulage and anxiety to push ahead to enable timber extraction to begin, schist, where plentiful, had to be used. This rock is practically useless for metalling; being soft and extremely fissible, it tends to form a tenacious mud when subjected to heavy traffic during rainy periods.

Bridges.

The most interesting, yet the most difficult, problem was the erection of two bridges, one having two spans of 11′, and the other one span of 15′. Both were built over boulder-strewn mountain streams; rivulets in summer and rushing torrents in winter. The location of the bridges had to be selected with regard both to the road and streams. As far as possible, in this instance, they had to be built so that the road could curve gently to and from and at the same time be at right angles to the flow of water. This required much preliminary examination of sites, marking of trial sites, etc., but amply repaid the time so spent, as once the proper sites had been selected the work proceeded quickly and efficiently.

The following is a short outline of the building of the two-span bridge. This was marked out by using a twine line accurately squared by checking the diagonals. The water was then diverted into a prepared channel at one side, and the boulders turned down stream. These boulders were used afterwards to form the new stream bed, which sloped gently to and from the bridge. The foundation was then sunk 2½ feet. It was 16′ long to allow for abutments. This was levelled, using concrete 3 : 1 mixture of sand and cement. The sand was tested for purity by shaking some with water in jam jars and leaving overnight to settle. All tests showed only slight traces of dirt. The foundation wall, about 3 feet wide, encased between timber panel (or mould) and the bank, was then built, using the above mixture, with stone filling. It was levelled at about 1 foot above the proposed new stream bed. The stones used in filling were placed 4 inches apart and about the same distance from the edge of the panel. All stones to which clay or humus adhered were washed, and all round stones broken to ensure good bonding. Each course of cement was tamped with a small stick, and from time to time, and at the end of the building a workman tapped the outside of the panel with a hammer. This gave a very smooth wall.

The pier was then built on the foundation wall, using 5 : 1 mixture of sand and cement. It was 2′ wide, 13½ feet in length at the base. The ends tapered 2″ for every 2 feet in height. This allowed sufficient length to embed guide rail hooks at both ends. This pier, when built to the required height, was levelled by using carpenter's level and straight edge. The outer edges to carry the guide rails were built level with the proposed level of the decking. The other side pier was similarly built. The centre pier differed in that two panels had to be used. These were held the required width apart by passing plain wire through the panels, and round opposite battens and twisting it between the panels until it pressed tightly to laths of the required width. The tops of the laths were held in position by cross laths nailed to battens. This formed a rigid box which, when quarter filled with concrete, could be pushed into the vertical. It will remain in this position unless subjected to a strong force.

Having built all the piers to the same level, nothing remained to be done but lay the timber girders and decking. To disperse the weight evenly along the walls 5 larch girders, approximately 8 inches square, were laid on wall plates 3 inches in depth. The girders were 1½ feet apart, one at the centre and two on either side. Owing to the width of the two spans, two sets of girders had to be used. These were joined at the centre with a scarf joint. The flooring, 9″ x 3″, and guide rails were then laid and flooring cut flush with outside of guide rails.

The second bridge was built with round timber. Four girders were used, two iron and two round larch girders with average diameter of 15 inches. No wall plate was used, all girders were levelled and then embedded in the concrete. The decking, consisting of round poles approximately 5″ in diameter, was then laid. Every fifth pole was pegged to the wooden girders and acted as tightening pole, the fourth pole being slightly wedged between it and the other three.

The new road was opened for lorry traffic on the 9th December, 1944, and, while there are still a number of minor improvements to be carried out, it is already proving of use in serving a large area of rapidly developing plantations which could not otherwise be exploited. Considerable quantities of poles and firewood are now being extracted and much more will become available later on. Its efficiency is such, that even after the very heavy rains of last autumn it has been successfully and safely negotiated by convoys of ten lorries at a time, which have removed materials from an area to which horse-drawn vehicles could formerly be taken, only with the greatest difficulty and with the lightest of loads.