IF GEN. HAIG SAID: "BUILD ME A ROAD TO BERLIN"—COULD YOU DO IT?

(Every Engineer in this Depot should know how to build, or help to build, a practical road—either for war use or for "the piping times of peace". Here's your opportunity to learn authoritatively the elementary rules about all roads. If you are farsighted and wise, you'll carefully save this series of articles, with your notes on other pertinent subjects—ready for the coming big emergency.)

(Part Two)

Widths and Grades.

Widths: Formerly the widths of metalled portions of a road were considered in multiples of eight. Now, owing to the universal use of motor trucks, with an increased width of wheel base, it is customary to consider the width of the traffic portion of a road in multiples of ten.

Actual width of military vehicles from outside to outside of wheel, exclusive of axle-tree projection, are as follows: — W. D. horse-drawn vehicles, 5'2" to 5'10"; motor lorries, 6' to 7'6"; tractors, caterpillars, howitzers, road rollers, from 7' to 8'9".

A ten-foot metalled portion will carry ordinary traffic in one direction. Twenty feet accommodates traffic passing in opposite directions, and is suitable for long stretches of country road. Twenty-four to thirty feet is necessary around concentration camps and thirty to fifty feet around terminals.

Grades: First class roads are those having no steeper slopes than 3 per cent; with a metalled portion from sixteen to twenty-four feet wide; and having no sharp curves, over-deep side ditches, or narrow fills; and where the subgrade is kept dry the year round.

Second class roads are those having no steeper clopes than 5 per cent, with a metalled portion ten to twenty feet wide and other characteristics as for first-class roads.

Third class roads are those having no steeper slopes than 5 per cent, with a metalled portion eight to twelve feet wide and with at least a few of the characteristics of first and second-class roads.

Motor lorries are guaranteed to haul their registered loads up 10 per cent grades. Traction engines will haul a load equal to their own weight up 10 per cent grades; twice their own weight up 5 per cent grades, and three times their own weight up 3 per cent grades.

What one horse can haul on the level, it requires two horses to haul on a 2 per cent grade; three horses to haul on a 4 per cent grade; four horses to haul on a 6 per cent grade; six horses to haul on a 10 per cent grade, and nine horses to haul on a 15 per cent grade.

Oxen work better on long gradual slopes than where there are flat stretches alternated by short steep inclines. Horses, on the other hand, work better where there are flat stretches with occasional stiff inclines. Pack animals, when well saddled, can be counted on to give good satisfaction on grades as follows: Pack mules, 16 per cent grades; pack ponies, 12 per cent grades; bullocks, 10 per cent grades; camels, 8 per cent grades.

Hasty Roads.

Tactical and not economical considerations are the ruling factors in hasty road construction. Permanence, durability, and maintenance are problems to be dealt with as they arise.

The circumstances which make the construction of a new road necessary, may also call for immediate action, not only to get the work started but to accommodate traffic during construction. This condition of affairs will force the engineer to ignore principles otherwise essential to good road construction. He will, however, as in the case of modern road construction, be guided by certain fixed principles characteristic of this class of work.

The following salients are submitted as principles closely associated with hasty road work.

Salients.

Reconnaissance: The general direction will likely be determined from a map. The first practical step is to walk over the ground in the direction the road is to take. Stake out the general alignment, taking advantage of all natural features which will minimise labour in making cuts, fills, culverts, bridges, etc.

Avoid, if possible, steep grades, sharp curves, marshy or shifting subgrades, locations subject to floods, etc.

Keep in mind the nature of the traffic the road is to carry, and the possibility of the road being improved and becoming permanent.

Clearing a Pathway: If the road is through a partly wooded locality a pathway throughout the total length should be cleared. The pathway should be wide enough for working parties and for light teaming such as is necessary at first.

Direction and Levels: As soon as possible after a pathway has been cleared, and the general alignment struck, definite levels should be taken and the final alignment staked out. The total width of roadway should now be cleared. Timber suitable for culverts, bridges, revetments, etc., should be cared for. Brushwood, suitable for making fascines and to corduroy marshy spots, should also be kept. A portion of the roadway, sufficient for traffic in one direction, should be stumped and levelled.

Dealing With Obstacles: The more difficult portions, such as cuts, fills, culverts, swamp roads, bridges, etc., should be got under way without delay. The whole aim should be to establish an uninterrupted communication along the total length of road as soon as possible. With this type of road it is reasonable to assume that the sooner traffic gets on it the sooner it will began to take shape.

Marshy Portions: To start with, a good foundation must be laid—NOT of stone as is sometimes done. Laying stone on a soft foundation is a waste of good material.

The best form of foundation—at least for a hasty road—is to corduroy the bearing surface, or what might be termed the subgrade. Logs, R. R. sleepers, fascines, etc., may be used for this purpose.

The first layer may be either at right angles to, or running in the direction of, the road. The top layer must be at right angles to the road. It does not follow from this that there must be three or four layers; one layer may be quite sufficient.

A continuous riband should be laid along the outer edge of the corduroy, and the ends secured to it. If the road is likely to develop into a permanent one it would be advisable to place the corduroy below the surface level—by this means it could be kept damp and free from air. Wood that is exposed to alternate wet and dry conditions soon rots.

Where lumber is plentiful, and time pressing, a plank road might be built. Longitudinal mudsills are laid to support transoms. The transoms are placed at intervals consistent with length of roadbearers. Roadbearers are laid as for bridgework.

If roadbearers can be procured that will reach over two or three transoms it will give a much greater steadying effect than if the joints all occur over the one transom.

The flooring usually consist of a layer of heavy planks, laids at right angles to the road, and a second layer of lighter, but tougher material laid diagonally, as a wearing surface. Ribands and hand rails should be provided as for ordinary bridge work.

Fills: The material forming fill should be well rolled or tamped from the start. Culverts should be built under deep fills—in fact, under ALL fills: this is a good rule to follow. In order that water, flowing through the culvert, will not undermine the fill, the culvert should be larger than seems necessary.

The lips and aprons should be well revetted with stone, timber or other suitable revetting material. Unrevetted earth rarely stands at a slope steeper than 1/1; therefore, when considering the width of base for a fill, it is necessary to add, to the proposed width of roadway, a measurement equal to twice the height of the fill.

Cuts and fills seem to go hand-in-hand. Hills are rarely cut entirely away. It is customary to use material from the cut to construct approaches on either side. The following tables may be of some use in estimating the amount of earth that can be shifted from cut to fill in a given time.

HAULAGE TABLE.
(includes loading)

Distance in feet.	Mode of conveyance and number of cubic yards that can be shifted in one hour.				
	Collapsable Box or Dump Wagons.	Carts or Wheel Scrapers.	Drag Scrapers or Slushers.	Wheel Barrows	Hand Barrows
40	. . . . .	. . . . .	. . 22.0 . .	. . 2.5 . .	. . 2.0 . .
50	. . . . .	. . . . .	. . 14.0 . .	. . 2.2 . .	. . 1.8 . .
75	. . . . .	. . . . .	. . 10.0 . .	. . 1.9 . .	. . 1.6 . .
100	. 12.0 . .	. . 6.0 . .	. . 8.0 . .	. . 1.7 . .	. . 1.4 . .
200	. 10.0 . .	. . 5.0 . .	. . 4.2 . .	. . 1.2 . .	. . 0.9 . .
300	. 8.6 . .	. . 4.3 . .	. . 1.2 . .	. . 0.9 . .	. . . . .
400	. 7.5 . .	. . 3.7 . .	. . 0.9 . .	. . 0.7 . .	. . . . .
500	. 6.7 . .	. . 3.3 . .	. . 0.7 . .	. . 0.6 . .	. . . . .
600	. 6.0 . .	. . 3.0 . .	. . . . .	. . . . .	. . . . .
700	. 5.5 . .	. . 2.7 . .	. . . . .	. . . . .	. . . . .
800	. 5.0 . .	. . 2.5 . .	. . . . .	. . . . .	. . . . .
900	. 4.6 . .	. . 2.3 . .	. . . . .	. . . . .	. . . . .
1000	. 4.3 . .	. . 2.1 . .	. . . . .	. . . . .	. . . . .

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