distinct type of foundation is that developed in Massachusetts in which there is a slightly V-shaped sub-grade with a filling of cobble or field stone, a method which is claimed to give more effectively than other types, a desirable under-drainage.

Experience has shown the superiority of roads with a foundation, such as the Telford type, in reducing the cost of maintenance under heavy traffic. Settlement is more uniform, and defective drainage is less destructive. If the natural sub-soil is strongly supporting, such as a dry, well-cemented gravel, the foundation may be omitted with saving of cost. Whether the Telford or Massachusetts type of foundation be allowed, the local material suitable for either should largely govern.

The width of roadway between gutters or drains, and the width of stone should be guided by the amount and character of traffic, and should ordinarily be less in strictly rural districts, increasing as roads converge into city streets. A minimum width of grade for trunk roads should be 24 feet with metal in the central 12 feet, and earth or gravel shoulders six feet wide on each side. Maintaining shoulders at six feet, and a maximum width of metal at eighteen feet, the maximum width of grade need not exceed thirty feet.

The camber on roads of heavy travel should be the least possible, consistent with good surface drainage, factors to be considered being the quality of road metal, class of binder, and gradient of the road. As is well known, roads with a sharp crown encourage travel in one central line of wheel-tracks, while a flatter surface permits more uniform wear.

A hard rock such as trap, or a bituminous binder, requires less camber than soft material and an inferior binder, while a steep grade requires an increased camber to drain the wheel tracks. Trunk roads of the best class may be given an average crown of one-third or one-half an inch per foot from centre to gutter.

**County or Main Market Roads.**—Roads of this class cannot as a rule follow closely English, French, German, or other standard, but must be built with a view to the particular needs of this continent, and of the locality. The immediate need is a long mileage, to be built as rapidly as possible, through districts where population is comparatively sparse, often where there may be little or no road-making material, and the available expenditure necessarily restricted by these and other conditions.

European engineers would, undoubtedly, if it were possible to reconstruct many of their roads, lay them with foundations, but the cost is prohibitive. No more is it practicable on this continent to build any but the most heavily travelled roads with expensive foundation. Instead, it is necessary to depend on good drainage, carefully maintained to keep the sub-soil dry and strong enough to sustain the road surface.

Road-beds should have sufficient drainage for the severest test, which in northern countries is that period of thaw in the early spring, lasting usually for two or three weeks; just as bridges have to be strong enough for the maximum load, and with waterway enough for the maximum freshet. If sub-soil drainage is sufficient for the test of spring, no break-up of the road crust need be feared at other seasons.

Old specifications for roads built before the period of railway construction in Ontario, required open drains on each side of the road, with bottom at least two feet below the crown of the road. In most cases the drain was deeper; and hills or spouty places were under-drained with trenches filled with field stone. Such roads have stood the test of time, and may be accepted as the standard of drainage required for the north; except that tile under-drains are taking the place of open ditches where they would otherwise be dangerous, unsightly or difficult to maintain. Drains of porous farm tile keep the sub-soil at its driest and prevent uneven settlement of the road crust into mud which is as destructive to a road when below the surface as when on the surface. Some counties of Ontario are using tile drains the full length of all their roads. Others use them only on wet and spouty hills; on level land which is exceptionally wet and retentive; and where the open drain would otherwise have to be dangerously deep to give sufficient fall and outlet. In the last case, the tile may carry some surface drainage, receiving it in catch-basins.

Closely associated with drainage is the grading of the road. Before a road is surfaced it should be brought to grades that ensure permanence. Hills should be cut down, low places filled, and the earth work brought to a substantial turnpike. The road surface will need renewal, but the grade, if properly made, will outlast even the bond issue. On roads of a secondary class elaborate surveys are unnecessary. A good foreman can obtain easy flowing gradients by grading from point-to-point, and would probably disregard stakes and profiles except in cases of extensive cuts and fills, new locations, tile drains, or doubtful surface drainage, which should always be staked by an engineer.

Roads laid on an earth foundation should be given a higher crown when newly constructed, than is desirable for perfect condition. Settlement will assuredly occur, and unless the road is too high to begin with it will become too flat. A road of a secondary class which in two or three years has settled to the desirable camber will give the greatest degree of durability, with least expense for maintenance. One inch to the foot from centre to gutter or edge of shoulder, for a completed, rolled road, will meet ordinary conditions; with a circular cross-section, the greatest part of the fall is on the earth shoulders.

The cost of a road, unless earthwork and drainage is of an exceptional kind, will depend on the width and depth of broken stone used. Wide flat roads are desirable, but narrow roads with a good camber cost less to build, and much less to maintain, unless a highly organized system of maintenance is created. For this class of road and earth grade twenty-four feet wide, shoulder to shoulder, will meet most conditions; but may be reduced to eighteen or twenty feet for least traffic. With shoulders six feet wide, the stone is put on from eight to twelve feet wide.

The consolidated depth of metal on roads is based on 8 inches for a moderately strong clay or sand sub-soil. This is modified according to the anticipated amount of traffic and quality of stone to resist wear; the maximum concentrated wheel loads; local tire widths and wheel diameters; bond of road metal and consequent distributing effect of the stone crust; the supporting strength of the sub-grade and opportunity for drainage.

Bituminous binders may be justified on heavily travelled suburban or motor roads of this class, but present practice in Canada tends to oiling as a preservative and dust preventive, owing to the less first cost of water bound macadam.

**Township Roads.**—Reduction of cost to meet township conditions requires that townships have as their ideal, the cheaper class of roads adaptable for main county roads. Grading is cheap, and should be perfected before metal is applied. Neglect to provide easy flowing gradients, and to sufficiently drain and turnpike are mistakes fatal to any road. Minor municipalities can make no mistake in creating the perfect earth road as their ideal base for such metal surfacing as their resources will permit. An earth-grade from eighteen to twenty-four feet shoulder to shoulder should be made, and a single track laid eight feet wide, of gravel or broken stone.