roadway might support a light rural traffic, it will be rapidly destroyed if subjected to commercial motor transport, including, for example, several 5-ton trucks.

The greatest improvement noted in American foundation practice is the use of cement-concrete foundations, or stone foundations of equivalent strength, on state trunk highway systems. The concrete foundation, as a structure, should be analysed from the standpoint of the external forces acting upon it, the stresses resulting from such forces, and the composition and depth of the concrete foundation to provide for the strains within it. Based on statistics furnished by many motor truck companies, the maximum concentrated load under one rear wheel may amount to 11,000 lbs. This load, therefore, distributed over the area of contact of the tire may be considered the force for which the foundation should be designed from the standpoint of direct compression.

The foundation may likewise be considered as a beam or slab, two or four concentrated loads of the above amount being considered as beam reactions, while the upward pressure of the earth against the base of the foundation may be considered as a distributed load. Depending upon the possible position of the loads assumed, the beam or slab may be considered as a continuous structure or one with cantilever projections. Again, assuming that the subsoil under certain sections of the foundation is not in contact with the base of the foundation, a beam or slab action may take place, considering the external force to consist of a single concentrated load of 11,000 lbs. and the beam or slab to have both ends fixed or to have one end fixed and one end free.

It is self-evident that several assumptions may be made relative to pressure on the subsoil, the conditions of the subsoil beneath the concrete foundation, the distribution of the external forces and impact forces.

Regard Foundation as Structure

Although data is meagre upon which to design concrete foundations, nevertheless, it is high time that a concrete foundation should be looked upon as a structure and designed as far as possible according to the methods now used in designing other structures. The design of the foundation is particularly complicated due to lack of knowledge pertaining to the distribution of the load through the concrete, the pressure on the subgrade supporting the foundation, and the manner in which the concrete foundation acts as a structure. It is apparent, however, that a series of assumptions may be made upon which the design of the concrete foundation may be used, and that the results may be used as a guide to determine the composition and depth of the foundation.

The highway transport engineer or manager can neither assume that drainage systems and foundations have been scientifically designed, nor that these important elements of a highway have been constructed in accordance with practice based on service tests. Highway transport literature contains many references to cases where motor trucks have become mired in poorly drained roadways or have broken through wearing courses supported by weak foundations.

When the transport survey is made, care should be taken to determine, by inquiries along the route, the ability of the roadway to carry heavy loads, during the spring especially. It is well to keep constantly in mind that an ideal roadway surface is not necessarily an indication that the drainage system and foundations are suitable for motor truck traffic.

From the foregoing discussion it will be seen that poor drainage and weak foundation on a section of a transportation route may readily wreck a highway transport business, or at least require the charging of higher rates to cover increased cost of operation.

Grades

Only general deductions may be made pertaining to requirements relative to grades for motor transport. Unfortunately, little data is at hand covering the relative efficiency of truck transportation over various grades on different types of roadway surfaces. Of course, the general deduction may be made that the cost of haulage varies directly with an increase in grade and that the tonnage which can be economically hauled varies inversely with an increase in grade. In all probability, the present fundamentals of grade design will not be modified until sufficient data has been accumulated to demonstrate that present practices are uneconomical either from the standpoint of motor transport or the maintenance of the roadway.

The cost items relative to tires, grease, oil, gasoline and lost time, and probable depreciation and maintenance, will be increased by material grades on transport routes. General allowance can be made, but close estimates are impracticable unless the transport engineer has had experience with exactly the same conditions which he encounters on a new route.

Widths of Roadway and Shoulders

Roadways economically designed must provide for carrying the traffic on the paved roadway surface and not rely upon earth shoulders to carry a part of the traffic or serve as turnouts. It has been demonstrated that the latter practice is not economical from the standpoint of the maintenance of the pavement or shoulders, nor is it efficient or safe from the standpoint of traffic using the highway.

In order that a two-traffic line highway should be satisfactory for all classes of vehicular traffic, it will be necessary to follow English inter-urban traffic practice, which requires that slow-moving—or, in this case, commercial—traffic, shall keep to the side of the roadway. It is, however, obvious that a heavy motor truck operator will insist upon allowing a certain amount of leeway between the outside wheels of the truck and the edge of the roadway, as many operators have had unfortunate experiences with motor trucks being stalled in soft shoulders or ditched.

From observations of commercial traffic made on many highways outside of municipalities, it is the writer's conclusion that it will be necessary to allow at least a foot clearance between the body of the truck and the edge of the paved roadway. Furthermore, these observations indicate that motor truck drivers travelling at speeds from 10 to 15 miles an hour will endeavor to maintain a clearance of 2 ft. between passing vehicles. A compilation of the maximum width of 8 ft. for each of two trucks and the clearances suggested, indicates that a minimum of 20 ft. for two lines of traffic is a conservative recommendation. It should be observed that the county highways of England and the national routes of France have been constructed with roadways having widths of not less than 20 ft. for many years.

If the transportation survey indicates that the amount of traffic will require provision for more than two lines of vehicles, a greater width than 20 ft. should be adopted, the additional width depending upon the character of the traffic. It does not require much imagination to reach the conclusion that many inter-urban highways will be subjected, during the next decade, to traffic which will necessitate roadways sufficiently wide to accommodate at least two lines of motor trucks and two lines of passenger cars.

The above discussion indicates that highway transport investigators will do well to give careful thought to widths of roadways on a proposed route. On a narrow roadway, say from 9 to 14 ft., there will be, in many cases, continual danger of running onto earth shoulders, with resultant serious loss of time if the truck should become stuck in soft material. Furthermore, a given width of roadway is able to carry a certain maximum traffic. As this limiting amount of traffic is approached or exceeded, there will be serious loss of time due to congestion of vehicles. The cost item of lost time, therefore, may be materially increased due to narrow and inadequate roadways existing on a given transport route.

Curves

Motor vehicle traffic has effected a decided improvement in the design of highway curves, especially in the direction of the easing of sharp curves, provisions for clear sight around curves, and the banking of roadways. The importance of these details will be accentuated by the development of motor truck traffic. Many routes have so many sharp curves that this element of highways may effect economic transport through lost time in negotiating such turns, in-