

roads was also described. It was pointed out that no money is forthcoming to the municipalities unless the roads are kept in proper condition. The government, besides employing inspectors and instructors, has its own supply stores for material and equipment.

The Quebec law does not permit the municipality to borrow for road improvement. The government does the borrowing either by debentures or bonds. The municipality pays 2% and the government the balance. The government pays for interurban highways, but can charge the intervening municipalities a fair rate thereon. In the construction of large bridges the municipalities are also required to pay a part.

One disadvantage of the Quebec system was stated to be that the government grant did not increase as the quantity for work for improvement increased.

In the discussion which followed Mr. J. F. Beam, Black Creek, Ont., advocated that road-making machinery should be an item not susceptible to the higher freight rate.

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Bridges and Culverts.

By Lucius E. Allen, Civil Engineer, Belleville, Ont.

The speaker traced the development of this phase of road improvement from old types of wood construction to simple girders and beams of steel and later to concrete construction, the latter having developed in this country within the last fifteen years. He observed that a systematic survey should be made of existing structures recording all characteristics and classifying them according to conditions of traffic, etc., with a view to deciding the type best suited to various conditions to be met in new work. It was felt that, owing to the fact that occasionally an unsafe bridge was to be met with, such structures should be replaced before this condition of unsuitability developed, else heavy damage suits, etc., might be incurred.

In constructing a new bridge the selection of proper material, careful inspection, adequate skill and application of scientific knowledge; careful mixing of concrete, and close attention to paving were matters to be kept in mind.

The best type of culvert was stated to depend upon conditions. The various forms to be found in ordinary practice were enumerated.

In discussing the paper, Mr. Norman M. McLeod, Toronto, advocated a discontinuance of the use of plank floors. In the case of light bridges, he felt that the surfacing should be of the same material, as far as practicable, as the road. A number of useful suggestions were given respecting suitable paving materials for bridges.

Mr. Frank Barber gave some valuable advice respecting the care and maintenance of bridges, abutments and approaches. It was suggested to clear out the ground between abutments so that the flowing water could wash both. In such a scheme as this a shorter span might well be used. Relative to approaches, the common use of wooden posts was referred to. Each pair of posts should be wired together. In regard to width of bridge and approach, some suggestions were made relative to the most suitable widths, the side slopes adjoining them, and proper care of the latter. It was stated that the earth slopes of bridge approaches, a very neglected feature in highway work, should not be steeper than $1\frac{1}{2}:1$. A steep slope is false economy. It is better to use old sods rather than seed in sodding these slopes.

Reference was also made to wing walls, their design and construction. The use of field and river stone to protect fills and provide paved gutters was also touched upon.

State Roads of New Jersey.

By R. A. Meeker, State Highway Engineer.

In New Jersey, state roads have been designed and constructed with adequate regard to cost. Materials in the neighborhood of each district have been used. Along the sea shore oyster shell roads are built. Gravel is used where convenient deposits are available, but owing to the presence of a great deal of clay therein, it has been found necessary to treat it with a liquid wood pulp. Roads thus treated can better resist wear and tear.

The speaker referred to bond issues, and stated that no pavement could be expected to outlast thirty years of service. He referred also to maintenance cost and the application thereto of fines, motor licenses, etc. The problem of adjusting taxation was an important one, particularly along the trunk roads.

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Foundations.

By J. Duchastel, City Engineer, Outremont.

The speaker traced the part which foundations have played in road construction through the various types from the days of the Romans. The necessity of permanent foundations was strongly emphasized. The drainage of subgrade was equally important, as the former depended upon it. The question of drainage is one which very frequently warrants expenditure upon expert advice.

At Outremont, the practice has been to use limestone for foundations, rolling it well and then covering it with a layer of trap or other hard rock, after which tar or oil is applied and well rolled.

Mr. Duchastel cited the importance of having roads rolled before the frost was entirely out of the ground.

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Machinery.

By Fred E. Ellis, Peabody, Mass.

The speaker outlined the importance to adequate road construction of the application of machinery and labor-saving devices for better results and for quicker construction. Machinery was costly, but if properly selected and operated, the expenditure was well warranted. He cited an example where a piece of road work costing \$60,000 might involve an expenditure of \$18,000 upon equipment.

Some interesting observations were made respecting the new or commoner types of dump wagons, ditching machines, crushers, and rollers.

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Dust Prevention.

By Major W. W. Crosby, Consulting Engineer, Baltimore, Md.

Up to ten years ago this subject received comparatively little attention, except on city streets or on limestone roads used by fruit growers. Dust was supposed to be inevitable. The automobile increased it, however, to such an extent that hygienic conditions, as well as road preservation itself, demanded that something be done to decrease the growing inconvenience. The antidote seemed to lie in curing the defects of the road rather than in bringing pressure to bear upon the traffic over it.

Owing to widely varying conditions, there is no one material or construction method that will provide relief. Selection must be made to suit conditions.