ECONOMICS OF LOW COST HIGHWAY BRIDGES

REVIEWED BY

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As time passes bridge engineers are brought to a fuller realization of the important part maintenance plays in the life and ultimate cost of bridges In the haste to provide bridges for our modern highways, construction has been uppermost in the minds of the engineers and now they often find themselves facing constant and ever increasing maintenance expense, much of which could have been avoided by more careful attention to design details

Mr. Seiler has well stated that the service life and upkeep cost " cannot be predetermined for any given (bridge) structure " There is dearth of available maintenance cost data and such as are available include much maintenance expense due to defective design or construction and preclude any but general conclusions The question of bridge economies is inseparably linked with bridges design Each of the materials has proven to be economical under certain service conditions and every bridge engineer should be familiar with the advantages and disadvantages of each material and be capable of making comparable designs using the materials alone or in combination for it is essential that designs used for comparative studies be equally well executed Engineers using the same specifications often vary greatly in their layouts and in the details and proportions of their designs

Careful study should be made before reducing the proportions of vital members lest the advantage in construction costs be only theoretical and actual loss be suffered by increased maintenance costs Important considerations other than first cost and maintenance such as location, speed of construction, availability of materials, maintenance of traffic, and appearance sometimes dictate the type of structure that should be used Often locations are encountered where ample funds are available and the possibility of the location being abandoned or the load capacity or width becoming inadequate are so remote that it is sound judgment to provide a structure designed for permanency Often the bridge site or other controlling factors are so favorable to a certain layout or type of structure and therefore, to one of the materials or combinations of materials, that the proper choice is apparent

In general, however, only thorough study coupled with the exercise of sound engineering judgment and vision will enable the engineer to arrive at the proper selection of type and materials, and while economic calculations are an aid, their limitations should be recognized.

Multiple or continuous concrete slab spans often prove advantageous where head room is limited and satisfactory foundation material is near the surface.

Concrete deck girders supported by concrete pile or concrete column bents, depending upon foundation conditions, are suitable for the intermediate range of beam span lengths

Steel stringers on H-column piles are suitable in certain locations if the thickness of metal used is sufficient to provide for loss from corrosion during the service life expected

Simple and continuous long span beam spans are being economically constructed up to 100 feet in length using the heavy steel I beam sections now rolled In fact this type has practically replaced the low trusses formerly used which were not adapted to widening

The experienced bridge engineer can accurately estimate the first cost of designs of the different types of bridges of concrete, steel or treated timber or combinations thereof, but much of the maintenance cost of a given bridge will depend upon the design, the materials used and the quality of construction obtained

There is an admitted danger of fire loss in timber construction and while the actual cost of carrying this hazard may be small where a large number of bridges are financed, the actual insurance rate should be used in considering the financing of a single structure Timber of good quality, well seasoned and properly treated will give the full service life claimed for it but timber if not uniform in growth, varies in quality and resistance to decay with the season of cutting, and may be greatly affected by storage and handling before and after treatment The added cost of the inspection and material required to insure the quality of each piece would be prohibitive The cost of maintaining a timber structure may vary, therefore, from replacement of a single piece to " piecemeal " renewal

Maintenance of a well designed and constructed concrete bridge should be confined to maintenance of the wearing surface or pavement Good concrete made from durable materials is permanent but although much improvement in its manufacture has resulted in recent years, instances of defective structures of poor design, faulty construction, and deteriorating materials are too often in evidence The maintenance expense may vary from nothing to that approaching the cost of renewal

Maintenance of a well designed steel bridge should be confined to maintenance of the protective paint coat and the wearing surface or pavement Steel as a material is dependable but the painting of steel structures is likely to be neglected which is a decided disadvantage which the designer can partially overcome by use of proper details and sections

The subject of the discussion is timely and much will have been accomplished if it leads to a more widespread comparison of materials

and to the compilation of accurate data on maintenance costs strictly chargeable to each material.

Before large expenditures can be justified on the basis of a longer life expectancy the engineer should be reasonably sure that the highway sector of which the bridge is a part is permanent and that the location, grade and alignment will always be satisfactory, because obsolescence in the past has been very costly and the cause of much embarrassment to those responsible for highway policies Much of this obsolescence has not been due to any lack of judgment on the part of the engineer, but rather to the fact that appropriations of funds for bridges were restricted under the intense public pressure for increased road mileage Many state bridge engineers used light design loadings and narrow roadways contrary to their better judgment and, following earlier precedent, selected bridge sites where the bridge costs would be a minimum without due regard to approach alignment Highway development is now at a stage where the engineer can in the majority of cases form a more intelligent opinion of needs of future traffic Certainly, in instances where there is possibility of abandonment or demand for change of grade or increase of width, a structure should be provided with a corresponding service life or one adaptable to such changes as may be required with a minimum loss and expense

When only low cost bridges are considered, and locations with controlling factors especially favorable to certain types are eliminated, it appears that this discussion is chiefly concerned with beam span bridges, *i. e*, concrete slab, timber stringer, concrete girder and steel stringer superstructures and timber pile and framed bent, concrete pile and concrete bent, and steel bent substructures

While difference in traffic service qualities exist, any modern type of bridge should provide a surface equal to or better than the approach road sections and, if not equal to that of a bituminous or concrete pavement, it should be adaptable to improvement when and if the approaches are so surfaced. Under such conditions there is no difference in transportation cost worthy of consideration.

In the writer's experience the concrete roadway slab has proven more economical and more satisfactory than bituminous surfaces on timber sub-floors Both initial and maintenance costs have been less for concrete than bituminous surfaces under the same service conditions for an eight year period

Treated timber pile trestle substructures with timber stringers and concrete roadway slabs are low in first cost and suitable for use over swampy streams where short spans will suffice and where the depth to firm foundation is considerable

Near steel rolling mills, steel stringers are often advantageous and can be used for longer spans