A STUDY TO DETERMINE THE OPTIMUM END SPAN LENGTH FOR A STANDARD FOUR SPAN INTER-STATE HIGHWAY GRADE SEPARATION

by 680

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SYNOPSIS

The objective of this study was to find the end span length resulting in the minimum girder weight for a four span symmetric four girder bridge under the following constraints:

1. The interior spans are 95 feet each.
2. There is to be no uplift at the abutments.
3. H20-44 loading is to be used.
4. The girders are to have a prismatic haunch over the interior supports. (The ratios of the moment of inertia at the supports to the moment of inertia in the positive moment regions of the girders investigated are 1.0, 1.5 and 2.0.)
5. Use the AASHO Specification 1965 Edition.
6. A non-composite reinforced concrete deck is to be used on the welded girders.
7. For design, use the uplift resulting from the loading which includes concentrated loads for moment but not for shear.
8. Use A-36 steel.

The results of this study indicate that the range of end span lengths in which the minimum cost girders will fall, with no uplift at the abutments, is relatively narrow. This range appears to be from approximately 47' to 52'. However, since this report was confined to working only with the superstructure, the most economical structural length was not necessarily found.

INTRODUCTION

In the design of highway grade separation structures, there is an increasing amount of emphasis being placed on safety and the removal of obstructions, which uncontrolled vehicles might otherwise encounter, from the side of the roadways. Many of these structures are designed using structural steel so that they may be constructed with a minimum of interference to traffic.

In the past, steel bridges normally have had an end span to interior span ratio of approximately 1 to 1.25, in order to give as near a balanced design arrangement as possible. Now, however, the interior span becomes quite long with the use of the present safety criteria. This is especially true if there is a slight skew. The interior span length can often approach 100 feet and in some cases there have been spans of over 135 feet. In using the balanced span arrangement, the end span is sometimes considerably longer than necessary to take care of the fill slope coming down from the abutment. There has been considerable discussion as to the economical advantage of shortening the end span to the point where uplift might occur at the abutment.

If the end spans are shortened drastically with respect to the interior span and uplift occurs, the AASHO Specification calls for a 100% overload increase, to oppose the uplift. This can sometimes be accomplished by using a heavy attached abutment. Unfortunately, the advantage of the attached abutment is not present in the design of a steel structure, so when uplift is encountered on these structure some positive means of hold down must be used. These devices become expensive to design and fabricate. They present a construction problem and there is a continual maintenance problem following construction. Therefore, it is desirable to design steel structures with span lengths which do not lead to uplift and still meet an economical length criterion.

This study used a trial and error method to determine the optimum end span lengths for various ratios of the moment of inertia over the piers to the moment of inertia at mid-span. The depth of the girder as well as the interior span length was held constant. The dead load weight of the girder was taken as the average weight of the girder and the design of stiffeners and diaphrams was omitted for purposes of simplifying the calculations.

The criteria which governed this study are as follows:

1. The interior spans are 95 feet each.
2. There is to be no uplift at the abutments.
3. H20-44 loading is to be used.
4. The girders are to have a prismatic haunch over the interior supports. (The ratios of the moment of inertia at the supports to the moment of inertia in the positive moment regions of the girders investigated are 1.0, 1.5 and 2.0.)
5. Use AASHO Specification 1965 Edition.
6. A typical cross section of the bridge is shown in Fig. A-3.
7. A non-composite reinforced concrete deck is to be used on the welded girders.