A STUDY TO DETERMINE THE OPTIMUM END SPAN LENGTH

FOR A CIRCULAR HAUNCHED GIRDER INTER-STATE

HIGHWAY GRADE SEPARATION

by 1264

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TABLE OF CONTENTS

INTRODUCTION

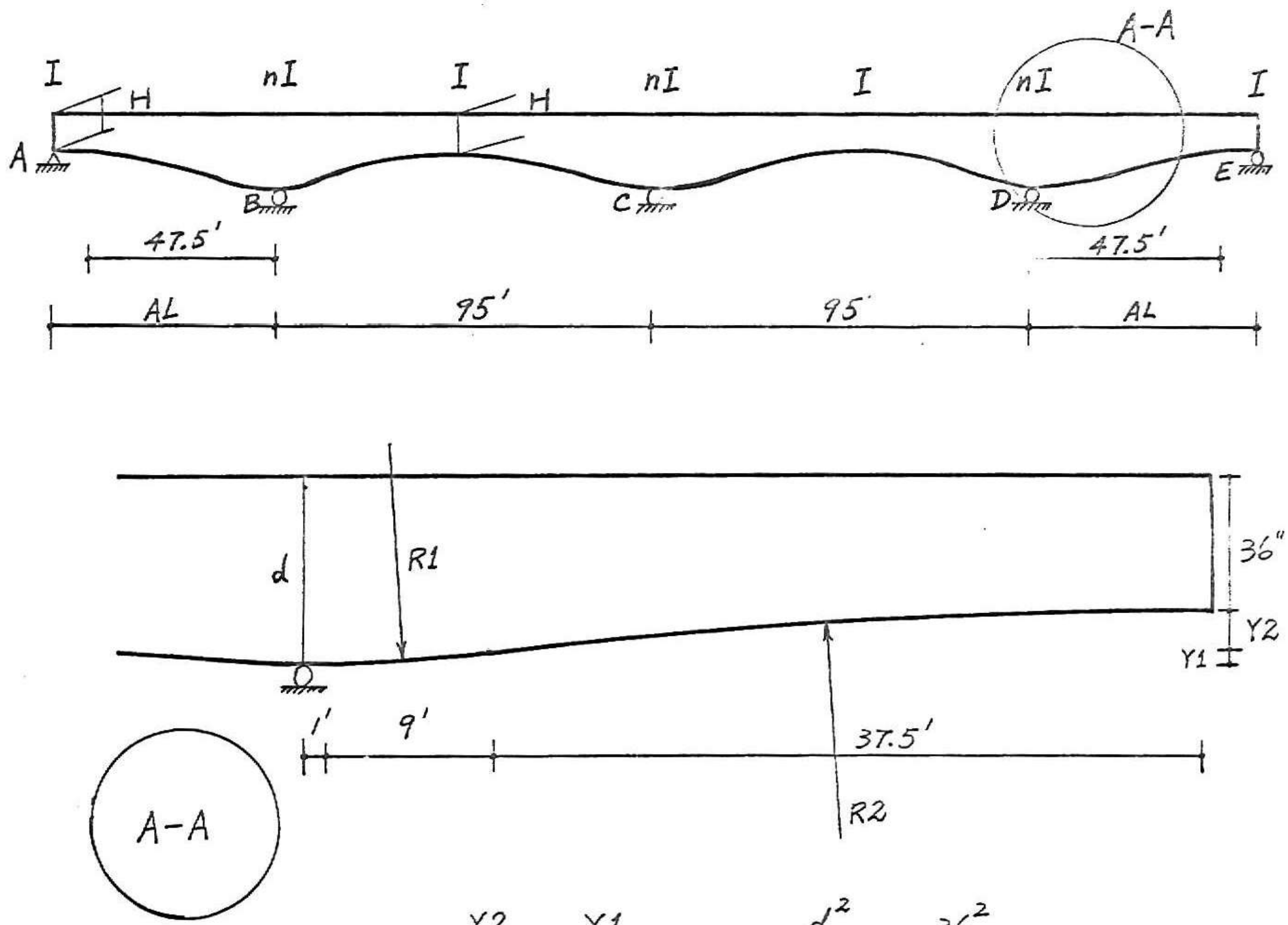
Today bridges of every type--suspension, arch, truss, plate box girder, etc.--are constructed of steel because of the strength, dependability, and permanence inherent in that material. In the past, for the purpose of obtaining as near a balanced design arrangement as possible, the normal proportion of an end span to an interior span of a steel highway bridge was approximately 1 to 1.25. Now, however, the interior span length will often approach 100 feet and in some cases, primarily due to the use of the current safety criteria, there have been spans of over 135 feet. This extension of the interior span length is particularly necessary if there is a slight skew. Following the extension of the interior span length, in order to meet the balanced design arrangement, the end span length is frequently longer than necessary to take care of the fill slope coming down from the abutment. Thus, there is considerable interest in shortening the end span to the point where uplift at the abutment is eminent.

According to the AASHO Specifications, if the end span is shortened severely with respect to the interior span and uplift occurs, adequate attachment of the superstructure to the substructure should be made and a 100 per cent increase in the live-plus-impact load should be taken into account. Unfortunately, the advantage of an attached abutment is not presented in the normal design of a steel structure and the 100 per cent increase in load increases the expense of the design. For these reasons, the design of steel structures with span lengths which do not lead to uplift and still meet the criteria of economy with safety is desirable.

There are several criteria which might be used to determine the optimum span length. One such criteria is total cost of structure including superstructure and substructure. Since the cost of substructure varies considerably from location to location and since the reinforced concrete cost of superstructure also varies depending on the structures location, it would have been rather difficult to calculate these costs in this study. Therefore, the criterion used in this study was total girder weight. Several simplifying assumptions used in the study are listed in OUTLINE OF THE DESIGN METHOD.

This study used a trial and error method for determining the optimum end span lengths for ratios of the moments of inertia of the girders over the piers to the moments of inertia of the girders at mid-spans of 1.5, 2.0, and 2.5. The trials were made with the end span lengths ranging from 50' to 80'. A total of 12 cases was investigated. The analyses and designs for the cases investigated are summarized in Table 1 and Fig. 10.

OUTLINE OF THE DESIGN METHOD



$$\frac{Y2}{12.1} = \frac{Y1}{2.9} \qquad \frac{d^2}{nI} = \frac{36^2}{1}$$

The Shape of the Haunched Girder

Fig. 1

(I) General Description of the Design Procedure

1. Given the depth of the girder, H, at mid-span or at the abutment.
2. Given the value of nI, where nI is the ratio of the moment of inertia of the girder over the pier to that of the girder at mid-span or at the abutment.

3. Calculate the depth of the girder over the pier from the given values of H and nI. Then compute the radius of the curve describing the girder haunch. The ratio of the moment of inertia of the girder at any section along the bridge to that of the girder at mid-span or at the abutment can then be found immediately.
4. Assume a value of AL, where AL is the length of the end span of the bridge.
5. Use the displacement method to find the ordinates of the influence lines for the moments at supports B and C, and to find the ordinates of the moment diagrams for the bridge under the action of the various loads, such as concentrated live loads or uniform dead loads.
6. Using the values calculated in Step 5, find the minimum girder weight which will prevent uplift at the abutment.
7. Assume a girder weight larger than the minimum required to prevent uplift.
8. Determine the maximum moment and maximum shearing force caused by the dead and live loads, using the data from Step 5. Design the girder section in accordance with the criteria of the current AASHO Specifications.
9. Calculate the weight of the girder chosen. If it is substantially different from the assumed value, repeat Steps 7 and 8 until a suitable section is obtained.
10. Calculate the total weight of the four girders in Kips.
11. Pick a new value of AL, and repeat Steps 5 through 10 until the pertinent range of AL has been covered.