TRAFFIC RAIL POST FOOTINGS

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Abstract

Results of investigations at scenes of highway accidents in which safety barriers have received severe impacts have shown that where concrete is used for post footings, the footings are not always constructed to the correct standard dimensions. The British Department of Transport specification calls for the footing to be 350 mm diameter (or 310 mm square) by 950 mm deep; footings are frequently twice the correct diameter and half the required depth. The use of cylindrical forms has been studied, in field trials, as a means of controlling the construction of the footings. A satisfactory performance has been achieved using a prefabricated cylinder to the correct dimensions in very poor ground conditions, where concrete footings would normally be specified.

Introduction

To ensure that post footings are installed to current specifications, a technique has been developed of prefabricating the footing; the method has particular advantages in poor quality soil. The objective of the specification is to ensure that the post footing is at least as strong as the post set into it, so that the post can develop its full strength during an impact on the barrier. Concrete footings are used when the ground conditions are inadequate to support driven posts. In the case of concrete footings, the specification requires that they be 310 mm square or 350 mm diameter by 950 mm deep for "Z" section posts (100 mm by 32 mm). Many of the footings inspected at sites, where safety barriers had been struck by vehicles, were not always constructed to the correct dimensions; they tended to be of hemispherical or conical form. To achieve maximum effectiveness from the safety barrier it is important that the post are held firmly in the ground in order that they an develop their full bending strength.

To control the construction of the post footings, the use of cylindrical forms has been studied in field trails when the ground conditions were known to be poor. Standard "Z" section posts were inserted into a variety of cylinders and subjected to horizontal loading until failure occurred.

Procedure

An area of ground at the edge of a highway nearing completion was made available for the footing tests. The soil conditions were known to be poor from tests that had been carried out to assess the soil performance. Holes for cylindrical forms for the footing were made by a powered auger mounted on the rear of a truck. To avoid interaction, holes were spaced at three (3) metre centers with the line of holes a minimum of 1 1/2 metres from the edge of the paved surface. The cylindrical forms were either plastic, 255 mm diameter (10 mm wall thickness) or mild steel sheet, 305 mm and 355 mm diameter (1 1/2 mm wall thickness) and each was 950 mm long. For experimental purposes, the use of concrete fill would have been inconvenient. Instead the cylinders were packed with timber in 20 mm layers cut to allow the insertion of 100 mm by 32 mm "Z" section standard fence posts to a depth of 420 mm. A pair of vertical bars was

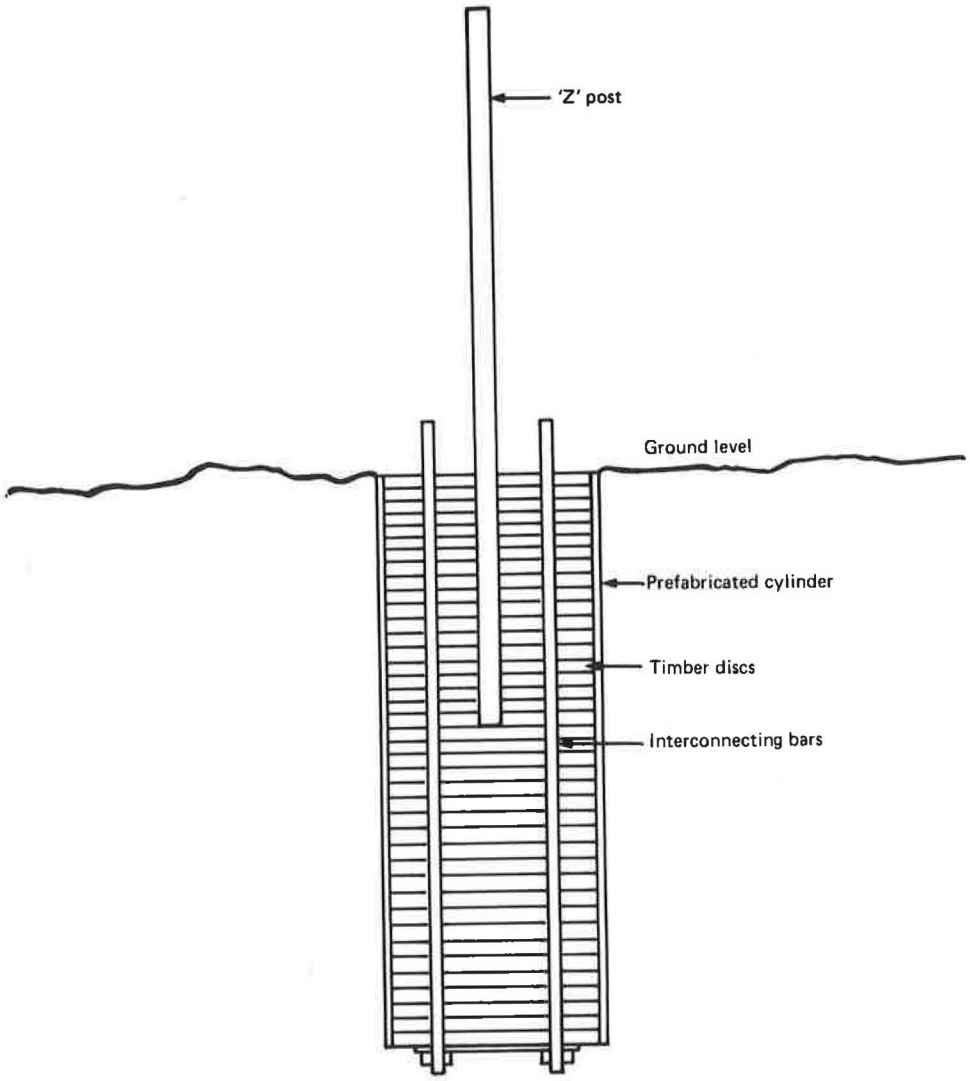

FIGURE 1 - Section through prefabrication footing - typical for diameter

also connected through the full depth to interconnect the timber discs and to aid extraction (Figure 1). This arrangement ensured that the post and cylinder behaved as if the post was embedded in a concrete footing of the same dimensions as the cylinder.

The posts were loaded through a winch cable connected via a load cell to the post at a height of 665 mm above ground level; the load was increased in 1 kN intervals and corresponding deflections were noted at the same heights as the applied load. Loading was increased until either the post or the footing failed, as indicated by increasing deflection for no appreciable increase in load. On completion of the site work, the footings were removed and the excavated soil returned and compacted.

In preliminary series of tests on posts located in a concrete pavement, the horizontal direction had been determined for which the bending strength of the Z-section post was greatest. Loads were applied in this direction in the post loading field trials, Figure 2.

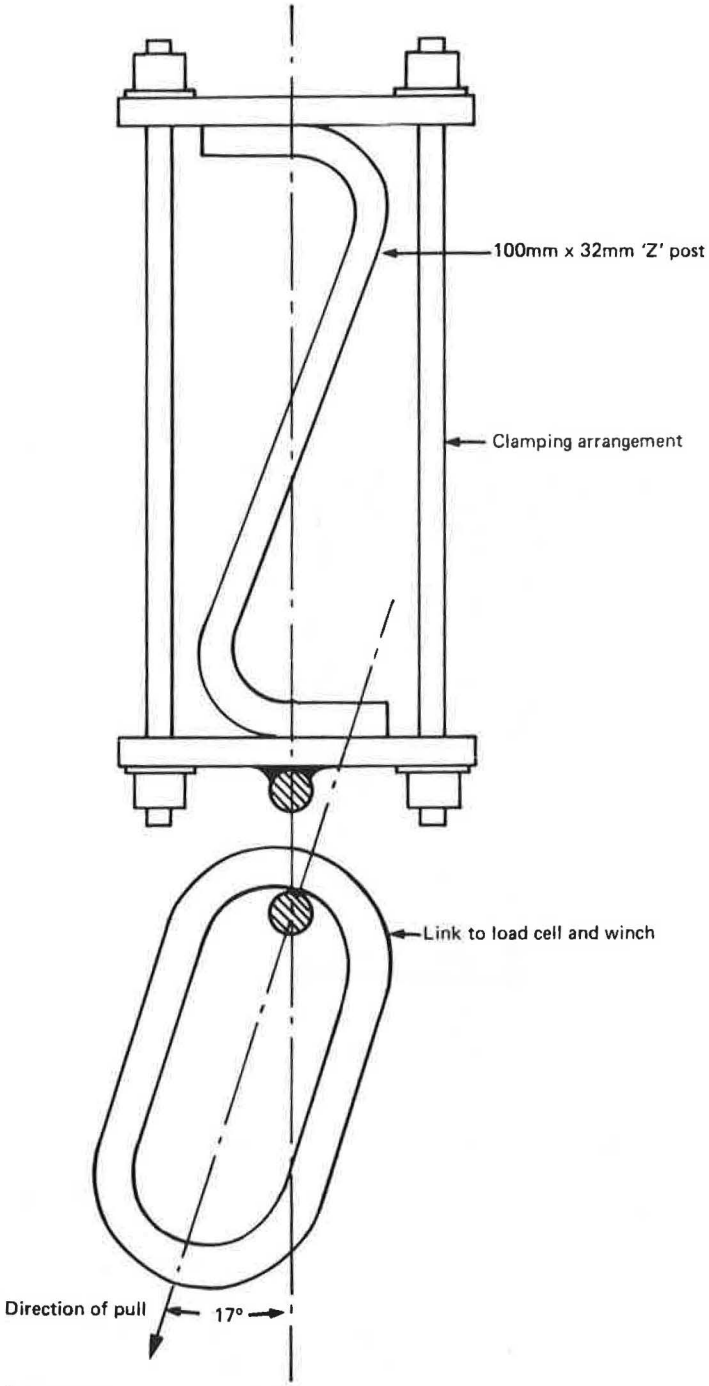

FIGURE 2 - Winch to post connection

Results

The results for the post loading tests are shown are Figure 3 (a-d) as load deflection curves; they fall into three categories:

Ground Evaluation

Loading tests on a post driven into the ground show clearly that the ground

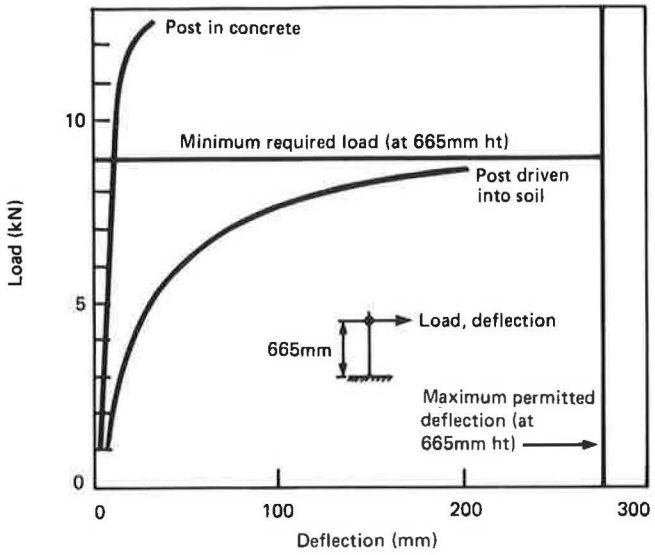

Fig. 3 (a) Load: deflection curves for posts in concrete and soil

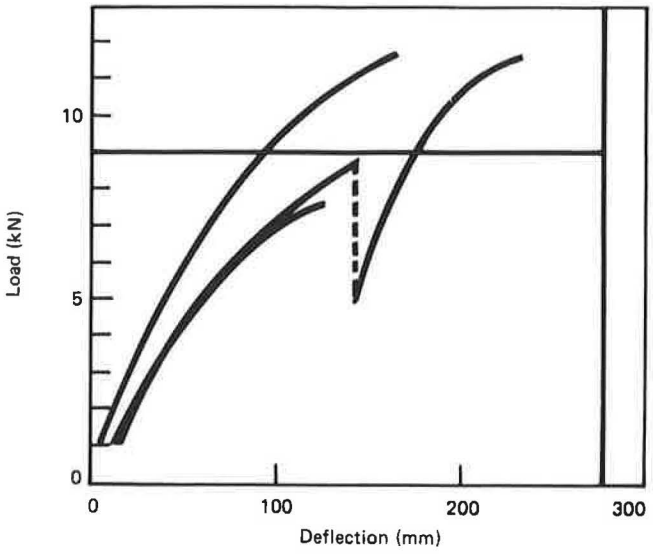

Fig. 3 (c) Load: deflection curves for posts in 305mm diameter cylinder footings

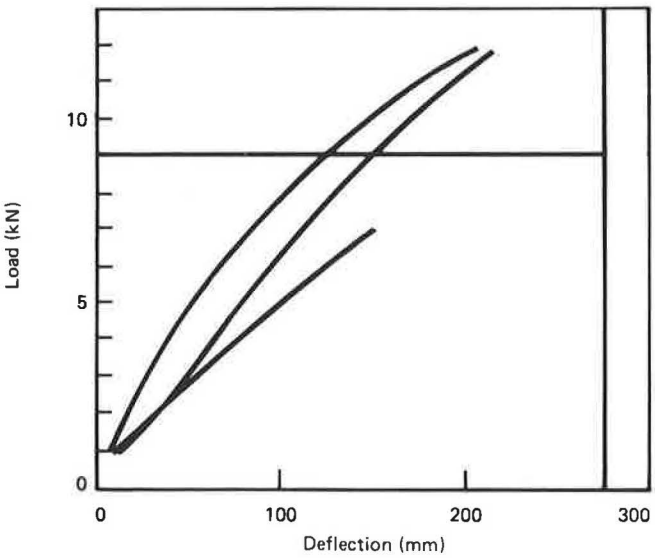

Fig. 3 (b) Load: deflection curves for posts in 255mm diameter cylinder footings

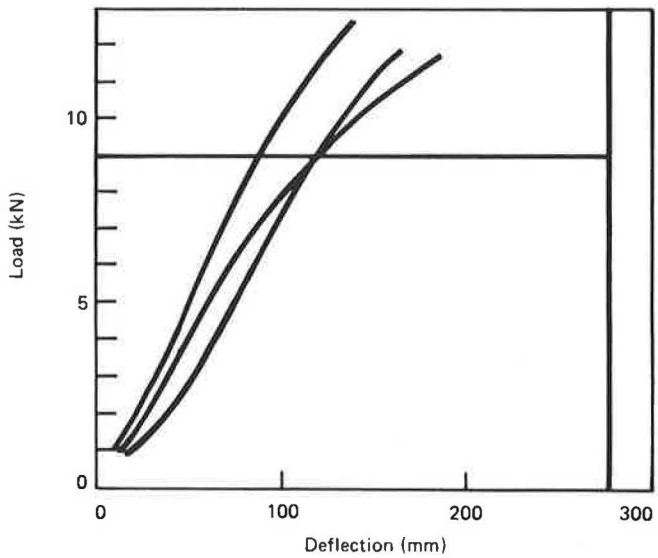

Fig. 3 (d) Load: deflection curves for posts in 355mm diameter cylinder footings

FIGURE 3

conditions did not meet the requirements set by the British Department of Transport for driven posts. These are that such a post is required to support a 6000 Nm moment with a deflection not exceeding 250 mm measured 600 mm above ground level. The maximum moment achieved was 5763 Nm when the deflection has reached 250 mm. When these requirements are measured 665 mm above ground level, the minimum load supported by the post should be 9023 N and the maximum deflection should not exceed 277 mm.

Standard Post Strength

With a post mentioned in a concrete pavement the load deflection characteristics for the post were determined. This indicated that a load of about 10800 N (at a height of 665 mm) could be applied before the post began to fail by a combination of twisting and bending.

Cylindrical Forms

Three loading tests were carried out on each of three cylinder sizes, 255 mm, 305 mm, and 355 mm diameter, in ground conditions similar to those used for the tests on a driven post (Section 3.1). The one 255 mm and one 305 mm diameter cylinder test, the maximum loads achieved were 6900 N and 7800 N respectively when the cylinders moved through the soil resulting in excessive deflection. In all the remaining cases, the peak loads exceeded the target value of 9023 N with deflection less than 180 mm, i.e., within the limit of 277 mm.

Discussion

The only cylinder size which consistently supported high loads with low deflections was of 355 mm diameter and this confirms the use of 350 mm diameter concrete footings as currently specified. The smallest cylinder test, 255 mm diameter, produced the greatest variation in results. This was probably attributable to variations in the soil composition, together with its moisture content, having a proportionally greater effect on the smaller size of footing. The techniques examined, demonstrated the viability of using cylindrical forms to control the formation of the footing to the correct specification. Augering the hole, insertion of the cylinder and then filling the cylinder with a support medium for the post, produced in the majority of cases a good performance when subjected to a pulling test. However to allow for variations in soil conditions and tolerances in workmanship, the standard diameter of footing (350 mm) is still recommended.

Conclusions

1. A loading test on a Z-section post, 100 mm by 32 mm, driven into poor soil showed that soil failed before the post developed its maximum strength.

2. Tests on Z-section posts in footings composed of timber filled cylindrical forms in poor soil showed that cylinders of 355 mm diameter and 950 mm long enable the post to sustain the loading specified by the British Department of Transport (such that the strengths of the footings exceeded that of the posts). Posts in cylinders of 255 mm and 305 mm diameter did not repeatedly achieve this strength.

3. The use of cylindrical forms for post footings set in augered holes much reduces the possibility of substandard footings occurring.

Acknowledgments

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