BENDING OF UNEQUAL SPAN CONTINUOUS PULTRUDED GLASS FIBRE REINFORCED POLYMER (GFRP) BEAMS

Geoffrey J. Turvey* and Jonathan Merlet†

* Engineering Department
Lancaster University
Bailrigg, Lancaster, LA1 4YR, UK
e-mail: g.turvey@lancaster.ac.uk, web page: http://www.lancs.ac.uk

† Visiting Summer Internee, Engineering Department
Lancaster University
Bailrigg, Lancaster, LA1 4YR, UK
e-mail: j.merlet@lancaster.ac.uk, web page: http://www.lancs.ac.uk

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Summary. Major and minor-axis flexure tests on continuous pultruded GFRP Wide Flange (WF) beams with unequal spans are described. It is shown that, provided the longitudinal elastic modulus of the beam material is determined experimentally, simple first-order shear deformation theory can predict deflections reasonably accurately, but rotations and strains rather less accurately.

1 INTRODUCTION

Several experimental investigations have been reported on the flexure of single-span pultruded glass fibre reinforced polymer (GFRP) beams, e.g. [1,2]. The majority have been undertaken to determine the elastic and shear moduli of the GFRP material. Analytical studies have also been undertaken to establish the effects of practical end connections etc on the flexural response of single-span pultruded GFRP beams, e.g. [3]. It appears that flexural tests on continuous pultruded GFRP beams with two equal spans are only just beginning to be reported [4]. The present paper extends the investigation in [4] to beams with unequal spans.

2 MATERIAL PROPERTIES

Geometric and strain gauge details are given for four coupons cut out of a length of the 102 x 102 x 6.4 mm Wide Flange (WF) continuous beam. The coupons were tested in tension to determine the average longitudinal elastic modulus of the GFRP which is shown to be substantially larger than the manufacturer’s minimum value [5].
3 TEST SET-UP AND TEST PROCEDURE

The experimental set-up for two-span continuous beam flexure tests is described. The beam was supported on three rollers to give spans of 3 m and 2 m. During each test a vertical point load at the centre of the longer span was increased until the deflection serviceability limit was reached. Mid-span deflections, support rotations and outer surface strains at mid-span and over the interior support were recorded. Tests were repeated three times for both major and minor-axis flexure.

4 FLEXURAL ANALYSIS

Two simple beam theories (classical shear-rigid and first-order shear deformation theories) were used to analyse the deformations of the continuous WF beams. Finite element (FE) software based on both theories was used to calculate deflections, rotations and strains.

5 COMPARISON OF EXPERIMENT WITH THEORY

The predictions of the two beam theories are compared with the experimental deflections etc. Most of the results are presented in the form of load versus mid-span deflection, support rotation and outer surface strains. These are supplemented by tabulated results which quantify the differences between the theoretical predictions and the experimental measurements.

6 CONCLUSIONS

It is concluded that deflections are predicted to within a few percent provided the experimentally determined elastic modulus is used instead of the manufacturer’s minimum value. Rotations and surface strains are predicted less accurately. It is also shown that accounting for shear deformation in the analysis leads to more accurate deflection predictions. Finally, it is suggested that simple beam theory can be used for design analysis of pultruded GFRP continuous WF beams.

REFERENCES


