International Journal of Solids and Structures 62 (2015) 269–270

Contents lists available at ScienceDirect

International Journal of Solids and Structures

journal homepage: www.elsevier.com/locate/ijsolstr

Discussion

Comment on "An asymptotic analysis of composite beams with kinematically corrected end effects" by Jun-Sik Kim, Maenghyo Cho and Edward C. Smith [Int. J. Solids Struct. 45 (2008) 1954–1977]

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ARTICLE INFO

Article history:
Received 28 January 2015
Available online 12 February 2015

Keywords:
Anisotropic beams
Asymptotic methods
VABS
FAMBA

ABSTRACT

In their paper Kim et al. (2008), Kim, Cho and Smith presented predictions that exhibited significant differences in bending-shear coupling for the CUS box beam from their own analysis (FAMBA) vis-à-vis from VABS (Yu et al., 2002, 2012). The actual differences between results obtained from VABS (Yu et al., 2002, 2012) and FAMBA, when executed properly, are shown herein to be very minor. Indeed, both stiffness models yield very acceptable results for a static analysis. Specifically, VABS does not significantly deviate, qualitatively or quantitatively, from 3D FEM predictions, in contrast to results presented in Kim et al. (2008).

1. Observations

In their paper (Kim et al., 2008), Kim, Cho and Smith develop a finite element-based beam analysis for anisotropic beams with arbitrary-shaped cross-sections with the aid of a formal asymptotic expansion method. After a detailed mathematical treatment of the Formal Asymptotic Method-based Beam Analysis (FAMBA), they consider various examples of composite beams with solid and closed thin-walled cross sections for verification purposes and the numerical results are compared with those from 3D FEM and other methods, such as the Variational-Asymptotic Beam Section analysis (VABS) (Yu et al., 2002).

In particular, Case 2, which describes a 15 deg CUS1 thin-walled composite box beam (whose ply material properties are listed in Table 1 and Section 6.2 of Kim et al. (2008)), is analyzed with VABS by taking the stiffness model given in Yu et al. (2002) and applying it to a typical Timoshenko beam model. The induced center deflection under a horizontal unit shear force computed by 3D FEM, FAMBA, VABS, etc., is plotted against the beam slenderness ratio in Fig. 16 of Kim et al. (2008), and the induced deflection of a 30 in.-long CUS1 box beam under the same load is plotted against the axial coordinate in Fig. 17 of Kim et al. (2008). While it is clear that FAMBA-2nd predictions are reasonably close to those of 3D FEM, the authors also show, and hence claim, that results from VABS deviate significantly (in excess of 50%) from those of 3D FEM. These claims call for the following comment.

Unlike the results reported in Kim et al. (2008), the stiffness model given in Yu et al. (2002) (as calculated by versions of VABS till v.3.1), when used in tandem with a 1D beam analysis code based on a geometrically exact intrinsic beam theory (GEBT), provides results that are both qualitatively and quantitatively in close agreement to 3D FEM. This can be seen in Figs. 1 and 2 of this Comment. Safely assuming that the fault lies neither with the Rankine–Timoshenko model that the authors used, since it seemed to have worked with other models, nor the geometrically-exact beam theory, which is designed to capture all the geometrical nonlinearities obtainable by a beam model, it seems logical to conclude that the major source of discrepancy was an error in applying the given stiffness model correctly to the macroscopic analysis by the authors and not solely due to errors in calculation of the 6×6 stiffness matrix by VABS.

2. Conclusion

In conclusion, we find that although there are minor differences in the prediction of the bending-shear coupling for the CUS box beam between VABS (Yu et al., 2002) and FAMBA (Kim et al., 2008), both stiffness models yield very acceptable results for a static analysis. Specifically, VABS does not significantly deviate, qualitatively or quantitatively, from 3D FEM predictions. Additionally, the authors would like to note that since the publication of Yu

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http://dx.doi.org/10.1016/j.ijsolstr.2015.02.011
0020-7683/

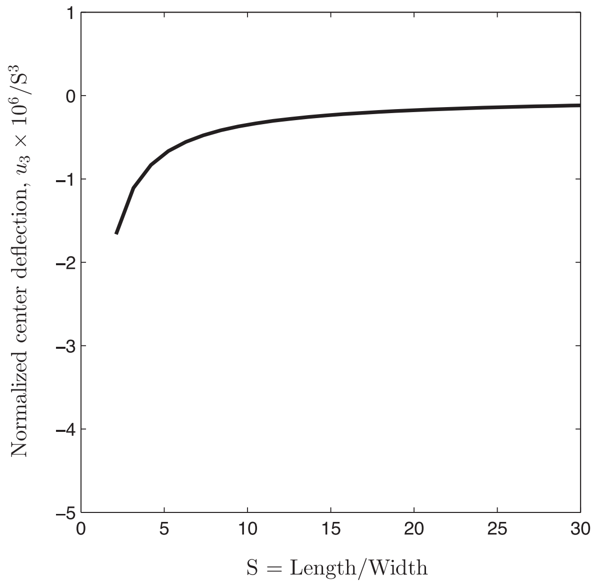

Fig. 1. Induced center deflection of a CUS1 beam under a horizontal shear force vs. length-to-width ratio (Case 2).

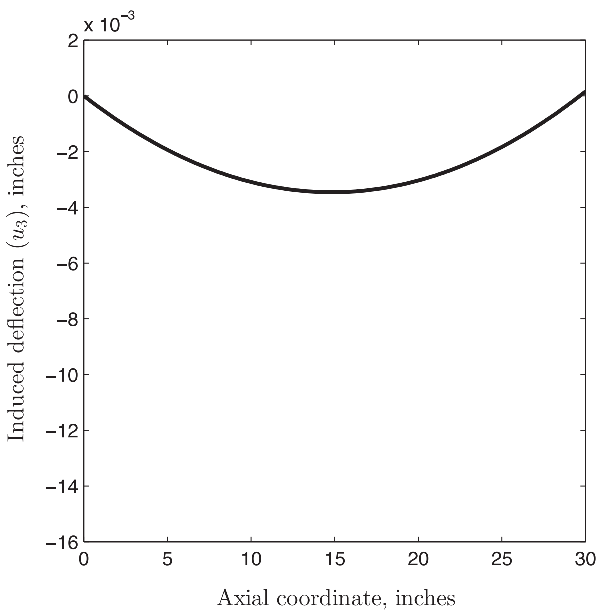

Fig. 2. Induced deflection of a CUS1 beam under a horizontal shear force (Case 2), *l* = 30 in.

et al. (2002), VABS has been updated and now provides results that are still further improved for some problems; (see Yu et al., 2012).

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