INTRODUCTION

Background

• High strength-to-weight ratio
• Easy to prefabricate
• Rapid assembly on-site
• Widespread usage from the 1950s

Aims

• Investigation into the benefits gained by using cold-formed steel purlins of yield strength 450 N/mm² instead of 390 N/mm² which is used in current practice. The degree of moment redistribution at the support is also investigated and a design framework is proposed.

NUMERICAL MODELLING

• Two-stage Ramberg-Osgood model (Gardner and Ashraf) used to model material behaviour of cold-formed steel
• Restraining effects of trapezoidal sheeting incorporated by using a 2-spring model
• Finite strip software CUFSM used to generate geometric imperfections to include in finite element models
• Corner properties have been enhanced due to the cold-forming process
• Boundary conditions applied to rigid plates to closely replicate the support clear
• Pressure load applied to bare system and whiffletree used to applied point loads on sleeved system
• Non-linear springs used to model bolts and SR4 shell elements for the purlins

RESULTS

• A drop in moment capacity at the support is observed at the failure load for slender sections. Stocky sections are able to achieve full moment redistribution, without a drop in capacity
• The load carrying capacity of a 2-span system can be predicted by:

\[ M_{\text{span}} = \frac{(qL^2 - 2M_{\text{support}})}{8L^2} \]

where \( M_{\text{span}} \) is equal to \( M_s \) and \( M_{\text{support}} \) is equal to \( \alpha M_s \)
• \( \alpha \) is the ratio of reduction in moment capacity at the support section and can be calculated from the formula:

\[ \alpha_{\text{design,R}} = \left[ 0.7 - 0.0045 \left( \frac{L}{d} \right) \lambda_{\text{cs},ve} \right] \left[ 0.003 \left( \frac{L}{d} \right) + 1.4 \right] \]

CONCLUSION

• A good fit was obtained for the design framework, with no significant scatter, therefore the proposed model can be used for both yield strength
• The load carrying capacity of the sleeved system exhibited a 14% increase when compared to its equivalent bare system. This increase corresponded to an increase of 6.22% in material required for the sleeve
• Increase of 11.4% in the ultimate load was attained when yield strength increased from 390 N/mm² to 450 N/mm²

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REFERENCES