SUMMARY REPORT

INVESTIGATION OF THE STRUCTURAL STABILITY AND INTEGRITY OF STEEL FOAM SANDWICH PANELS

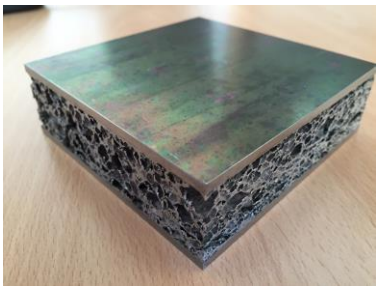
Dr S. Yiatros & Prof F. P. Brennan

Introduction

INSIST is an experimental investigation on the structural stability and integrity of novel steel foam sandwich panels (SFSPs) under monotonic and cyclic loading. Metal (including steel) foams is a special type of porous metal that can combine usual metallic structural properties like plasticity and strength with low weight and enhanced energy dissipation. The initial consideration for metal foams to perform as lightweight cold formed plate components, was soon dismissed due to its poor strength in tension and a more appropriate function for metal foam as metal component was highlighted as core in sandwich structures or infill in hollow sections, exhibiting merits in buckling mitigation and energy dissipation. Despite the slow uptake of the material from the industry, a few European manufacturers started appearing which will lead to serial production and decrease in the cost. The overarching aim of this project was to initiate the assessment of the potential of steel face/steel foam core panels in stability and integrity in order to pave the way for the development of design rules for the structural engineering industry

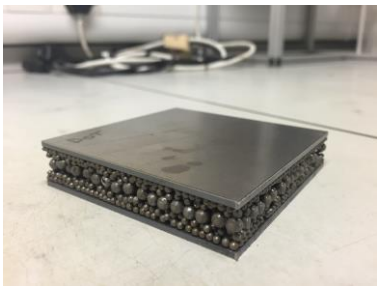
The project

The response of two types of metal foam panels has been studied, specifically SAS (Steel face Aluminium Foam Sandwich) and SFS (Steel face steel foam sandwich) with single density and graded density cores as shown in Fig 1.



SAS specimen.

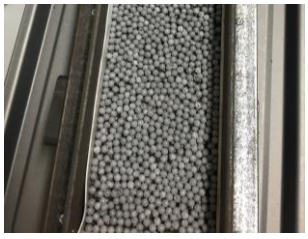
SFS 4 (Uniform density).



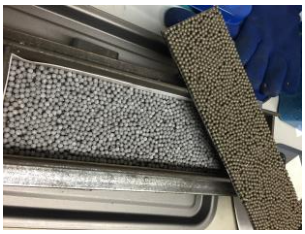
SFSGRD (Graded density).

Fig.1 Samples of the metal foam sandwich panels used in the investigation.

SAS panels were manufactured by Havel GmbH, while SFS prototypes were produced at Cranfield using steel plates and steel foam in the form of steel hollow spheres produced by Hollomet GmbH (Fig 2).



Base layer in mould.



Middle layer in mould.

Sandwich formation.

Fig.2 Three-step production of SFS prototype panels at Cranfield.

INSIST – Investigation of the structural stability and integrity of steel foam sandwich panels. This project has received funding from the European Union's 7th Framework Programme for research, technological development and demonstration under grant agreement no. 623874

A number of different experimental tests were undertaken in the newly constructed Structural Integrity Laboratory at Cranfield, testing in total more than 140 specimens. The types of tests and outcomes are highlighted in the infographic in Fig. 3.

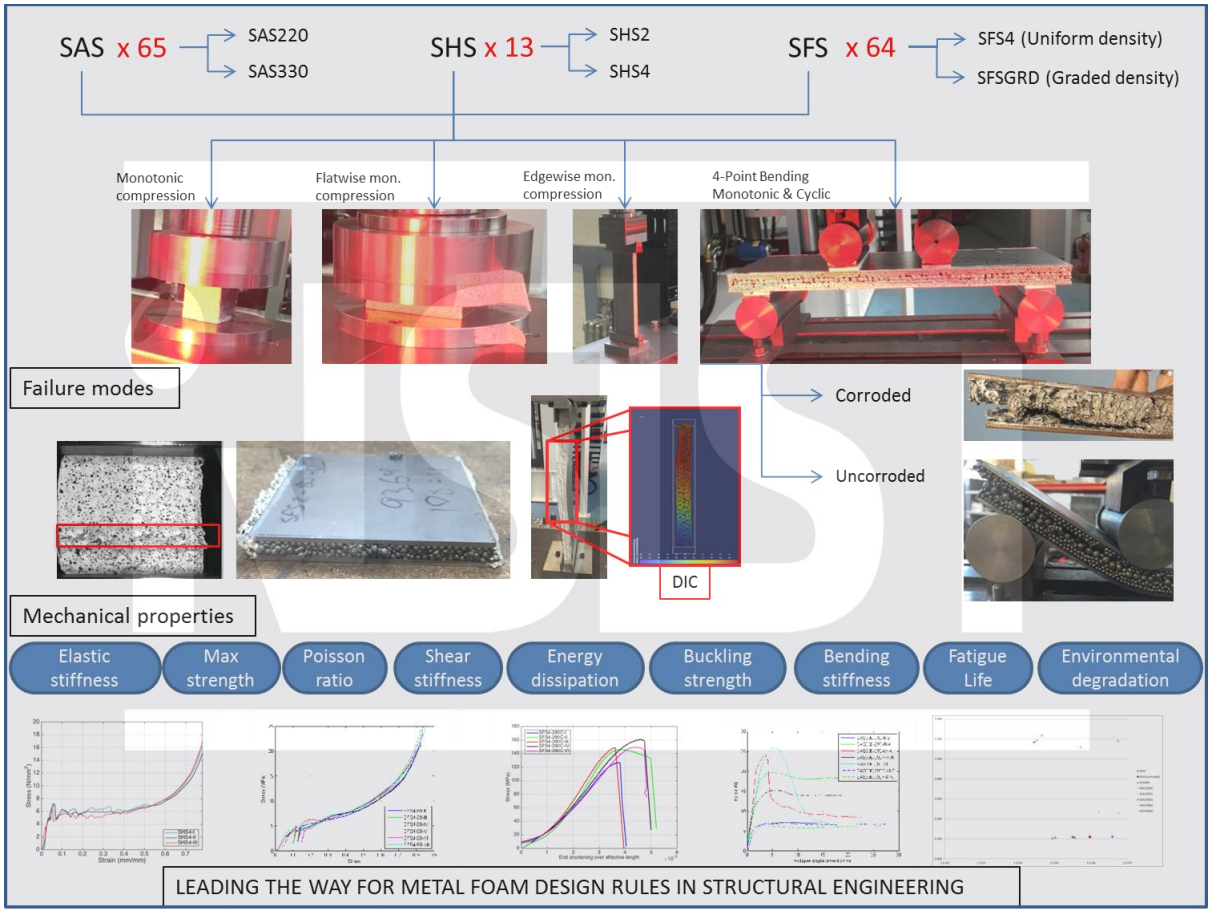


Fig.3 Overall description of the experimental investigation

Results

The series of undertaken tests have provided insight in the modes of failure of both types of sandwich panels (and metal foams) under different loadings, as well as to the material properties degradation due to exposure in marine (North Sea) environmental conditions. Using Digital Image Correlation (DIC) techniques we were able to create strain maps, calculate compressive and shear stiffness and Poisson ratios while cyclic bending tests have provided useful insight on the integrity and Fatigue life of the panels which is highly influenced by the manufacturing method. Numerical models were also developed and calibrated using the experimental results. Such a model was used in a wind turbine tower subcomponent with early results indicating a promising future for the use of metal foam sandwich panels in the industry.

Expected impact

Some initial results of the project have already been disseminated in international conferences and visits to industrial stakeholders. Journal articles are currently under preparation and there is already a small follow up project funded by the Institution of Structural Engineers to assess the inherent multifunctionality of metal foam sandwich panels in mitigating buckling and damping vibrations. The dissemination of this work will continue by communicating with industrial stakeholders through institutional talks and visits in order to contribute in the development of design rules and standards for widespread use of SFSPs. For more information about the project, visit www.insist-eu.weebly.com.

INSIST – Investigation of the structural stability and integrity of steel foam sandwich panels. This project has received funding from the European Union's 7th Framework Programme for research, technological development and demonstration under grant agreement no. 623874