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Selected Publications:

Giavotto V., Poggi C., Castano D., Guzzetti D., Fezzani M. Buckling Behavior of Composite Shells under Combined Loading // Proceedings of 17th European Rotorcraft Forum - Berlin, September 1991, pp. 84-1-84-13.

Poggi C. Characterisation of materials, Brite – Euram Project: DEVILS, Report WP04.DR/PM(1), Politecnico di Milano, Italy, 1996.

Carvelli V., Panzeri N. and Poggi C., 2000. Numerical and experimental buckling analysis of GFRP shells for under-water vehicles, Computational Methods for Shell and Spatial Structures, IASS-IACM, Athens, Greece 2000.

V. Carvelli, N. Panzeri and C. Poggi (Department of Structural Engineering, Polytechnic of Milan, Piazza Leonardo Da Vinci 32, 20133 Milan, Italy), "Buckling strength of GFRP under-water vehicles", Composites Part B: Engineering, Vol. 32, No. 2, 2001, pp. 89-101, doi:10.1016/S1359-8368(00)00063-9
ABSTRACT: The paper is concerned with the structural response of a composite shell structure intended as a model of an under-water vehicle for service in sea environment. The main objective of the research is the prediction of the collapse pressure using both analytical expressions and linear or non-linear numerical analysis and the following comparison with the experimental pressure obtained in off-shore tests. The structure is composed of three basic parts with regular geometry: a cylindrical part (with the following geometrical properties: R/t=30.5, L/R=2 being the internal radius 305 mm, the length 610 mm and the thickness 10 mm) and two conical and spherical end-closures with the same thickness. The cylindrical shell was made up of 7 plies of E-glass woven roving with polyester resin. Various structural analyses were conducted before performing the experiment in the sea to verify the reliability of the analytical and numerical tools. Firstly the entire model was analysed to predict the nature of the collapse (material failure or elastic buckling) and it was stated that the collapse was due to elastic buckling of the cylindrical part. Consequently, the attention was focused on this component and approximation formulae for the evaluation of the linear buckling pressure of isotropic and composite cylindrical shells were used together with finite element models. Afterward the study was enlarged to consider the effects of the recorded geometric imperfections into a non-linear buckling analysis. The collapse pressures were compared to the design values derived from the available recommendations and to the experimental result obtained in an off-shore test (1.3 MPa).

Chryssanthopoulos, M. K., Giavotto, V., and Poggi, C., "Statistical Imperfection Models for Buckling Analysis of Composite Shells," Buckling of Shell Structures, on Land, in the Sea and in the Air, J. F. Jullien, ed., Elsevier Applied Science Publishing Co., Inc., New York, 1991, pp. 43-52.
ABSTRACT: Buckling design of cylinders under axial compression is sensitive to the assumptions made in the modeling of initial imperfections. Normally, imperfection modes are selected solely on the basis of buckling mode considerations and their amplitudes determined using existing tolerance specifications. Whilst this approach may be used for metal cylinders, it cannot be readily applied to the design of fibre-reinforced composite cyloinders where the effects of manufacturing on imperfection characteristics have not yet been studied in any detail. This paper presents results from a statistical analysis of imperfections on two groups of composite cylinders manufactured by lay-up. Dominant features are quantified and the effect of fibre

orientation on imperfeciotns is examined. Simple models describing the random variablility of imperfection modal amplitudes are presented in order to be used in buckling strength studies.

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"Characterization of manufacturing effects for buckling-sensitive composite cylinders", Composites Manufacturing, Vol. 6, No. 2, 1995, pp. 93-101, doi:10.1016/0956-7143(95)99649-D
ABSTRACT: This paper presents a detailed statistical analysis on geometric imperfections recorded on two series of nominally identical composite cylinders. These defects can be classified in two categories, both due to the particular manufacturing method used: out-of-roundness and change of thickness due to the overlapping of various layers. The statistical analysis is developed for various purposes: to evaluate the common properties of cylinders with different laminations, to build up a characteristic model for the geometric imperfections suitable for probabilistic simulations in buckling analysis and to identify the parameters for quality control processes. The analysis of the change in thickness due to overlapping layers allows evaluation of the stiffening effects of the manufacturing process that, in some cases, could affect the buckling behaviour of composite cylinders. A standard procedure for the characterization and qualification of manufacturing processes for composite shells, with particular attention to the factors that influence their buckling behaviour, is proposed.

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"Buckling design of conical shells based on validated numerical models", Thin-Walled Structures, Vol. 31, Nos. 1-3, May 1998, pp. 257-270, doi:10.1016/S0263-8231(98)00006-8
ABSTRACT: In most shell buckling codes, guidance on the design of conical shells is restricted to unstiffened cones and even in this case the clauses are based on the procedures for cylindrical shells. Virtually no guidance is offered on stiffened cones and the particular characteristics of conical shells are not treated in detail. In this paper, use is made of finite element analysis to quantify critical elastic response and imperfection sensitivity through numerical models, whose adequacy has been quantified through comparisons with test data. The finite element results obtained were aimed at validating existing design recommendations for unstiffened cones and at developing a design approach for stringer-stiffened cones under compression, with a philosophy and format compatible with the European Shell Buckling Recommendations (ECCS).

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"Collapse strength of unstiffened conical shells under axial compression", Journal of Constructional Steel Research, Vol. 57, No. 2, February 2001, pp. 165-184, doi:10.1016/S0143-974X(00)00013-4
ABSTRACT: The paper presents the results obtained during a test programme involving unstiffened steel cones in compression. Due to the relatively low slenderness of the specimens, the failure was in all cases significantly influenced by plasticity effects. A plastic mechanism approach, including second order effects, is shown to be a

simple and effective tool for predicting the collapse load and also for simulating the load-shortening response. The derivation of the theoretical expressions pertaining the mechanism are summarised and some aspects regarding the solution procedures are presented. Comparisons between the proposed mechanism approach and the experiments are reported. Finally, some design considerations and comments with regard to existing shell buckling codes are presented.

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“Stochastic imperfection modelling in shell buckling studies”, Thin-Walled Structures, Vol. 23, Nos. 1-4, 1995, pp. 179-200, Special Issue: Buckling Strength of Imperfection-sensitive Shells
doi:10.1016/0263-8231(95)00011-2
ABSTRACT: One possible avenue that may improve design against buckling is to recognise and account for the random nature of initial geometric imperfections introduced by manufacturing. This paper presents the application of a probabilistic methodology to the design and analysis of cylindrical shells under axial compression. Results from two cases are presented and compared: the first involves stringer-stiffened steel cylinders failing elastoplastically, whereas the second examines unstiffened composite cylinders buckling elastically. In both cases, the method is underpinned by statistical analysis of imperfections measured on nominally identical specimens. Nonlinear FE analysis is used for strength assessment and the results of the statistical analysis are introduced in the imperfection modelling. It is demonstrated that the method has advantages over code design based on ‘lower bound’ curves, in terms of the calculated buckling loads but also in offering a systematic and rational way by which randomness in imperfections can be assessed.

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“Probabilistic imperfection sensitivity analysis of axially compressed composite cylinders”, Engineering Structures, Vol. 17, No. 6, July 1995, pp. 398-406, doi:10.1016/0141-0296(95)00048-C
ABSTRACT: Buckling analysis of cylinders under axial compression is sensitive to the assumptions made in the modelling of initial imperfections. Normally, imperfection modes are selected solely on the basis of buckling mode considerations and their amplitudes are determined using tolerance specifications in codes or experimentally recorded values. Whilst this approach may be used for metal cylinders with some confidence, due to the many test results available for validation purposes, it is not appropriate for the analysis and design of fibre-reinforced composite cylinders where the test results are limited and the effects of manufacturing on the imperfection characteristics have not yet been studied in detail. This paper presents a methodology for probabilistic buckling strength assessment based on the results of a statistical analysis on imperfections on two groups of composite cylinders manufactured by lay-up. The dominant features are quantified and the effect of fibre orientation on imperfections is examined. Simple models describing the random variability of imperfection modal amplitudes are presented. Using these probabilistic models, characteristic imperfection shapes are developed for fibre-reinforced cylinders and their use in buckling strength prediction and tolerance specification is demonstrated.