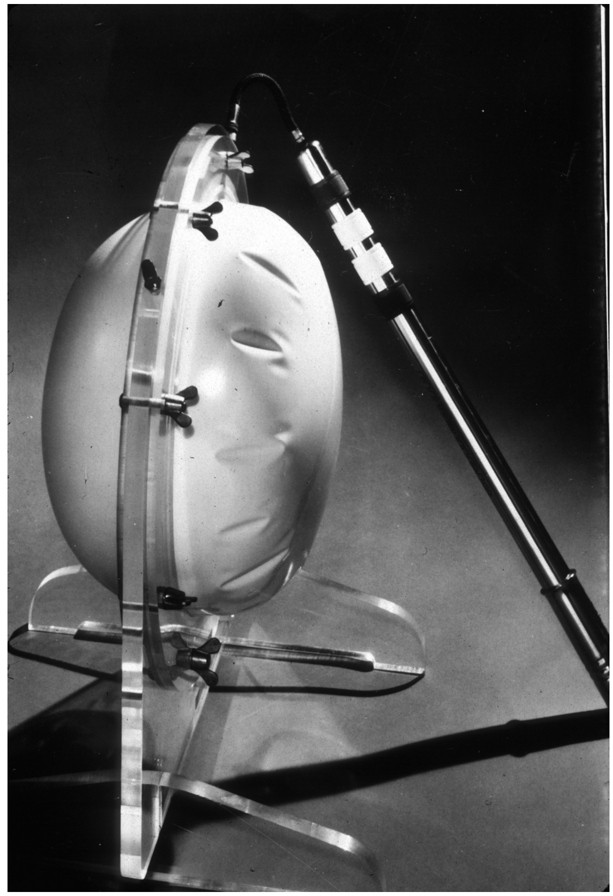

Professor Gerard D. Galletly (1928 – 2013)

The experiments were conducted by Professor Gerry Galletly at the University of Liverpool during the late 1970s and early 1980s.

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IN MEMORIAM (anonymous, perhaps by his University of Liverpool colleague, Professor Jan Blachut?)

GERARD DUNCAN GALLETLY 17/03/1928 — 02/12/2013

Emeritus Professor Gerard Galletly, who has died in Southport aged 85, was one of the world's foremost experts in the field of the buckling of shell structures.

Gerard Duncan Galletly, the eldest of four children of John Galletly, a Merchant Navy officer, and his wife Marion (née Musker), an overseer at a local dyeworks, was born on 17th March 1928 in Bootle, Lancashire. He attended Linacre Primary School and Bootle Grammar School, before being evacuated with his schoolfellows to King George V Grammar Schoolat Southport during World War II. At the age of 16 he became the youngest undergraduate ever to be admitted to Liverpool University, from where he graduated with honours in Civil Engineering in 1947, having consistently come top of his year and having been awarded the Hele-Shaw Prize and the McMenemy Award.

On graduation he joined the Royal Air Force as a Pilot Officer and was stationed in Germany, where he was involved in the mechanics of constructing the world's first concrete runway, at Hamburg's Fuhlsbüttel Airport, before being promoted to Flying Officer in 1948.

In August 1949 he resigned his commission and set sail for the United States of America, where he had been awarded a Henry Loomis scholarship and a Fulbright Travel Grant to study for a Master's degree at the Massachussetts Institute of Technology. After obtaining this degree in June 1950 he decided to remain at MIT for two further years to study for a doctorate in the analysis of reinforced concrete shear walls, which he concluded in September 1952.

Galletly then began work as a research engineer in the Structural Mechanics Division of the David Taylor Model Basin, being promoted to Head of the Plates and Shells section one year later. In that capacity he began to investigate the behaviour of pressure vessels under certain loads and stresses, a subject which would occupy the vast majority of the rest of his career. As a result of that work he was asked to participate in the first dive of a novel submarine, the *Albicore*, and to conduct tests which verified his own theoretical calculations.

In 1953 he married Marjorie Archer from Colne, Lancashire, who was to be his companion for over fifty years. Then in April 1955 the couple moved across the continent to settle in Emeryville, California, where Gerard had been invited to join the Shell Development Company. During his years there he published what was to become possibly the most important and influential of all his papers: "Torispherical Shells: a Caution to Designers", loosely based on the collapse of a similar pressure vessel belonging to another oil company in 1956 which sadly had fatal consequences. The publication of this paper led other companies to re-evaluate the designs of their own pressure vessels; design codes were changed to reflect his new findings, and undoubtedly this prevented further loss of life in similar situations.

Seeking new challenges, in September 1961 he accepted the position of Assistant Director of the Material Mechanics section at Pratt and Whitney in New Haven, Connecticut. Despite the research projects there not being in his primary area of expertise, he spent the following three years investigating problems involving aircraft turbine engines, before being appointed in 1964, at the age of 36, to the chair of Applied Mechanics, and Head of the Applied Mechanics Group, at his *alma mater*, the University of Liverpool. It was here that he was to spend the remainder of his career, continuing to investigate problems involving the buckling and collapse of shell structures for the next 31 years, before finally retiring in 1995 at the age of 67. During this time he published 90 further papers, several of which were awarded prizes by the Institute of Mechanical Engineers and the American Society of Mechanical Engineers. He was elected to the Royal Academy of Engineering in 1989.

Just before his retirement he was awarded a doctorate *honoris causa* by the Cracow Institute of Technology, both for his outstanding contribution to the field of shell buckling and for his unfailing support over two decades for Polish researchers who were seeking to establish themselves in Britain. He was the first Briton to receive such an accolade.

In retirement he devoted himself to caring for Marjorie, who pre-deceased him in 2009. For the last three years of his life he lived in Southport where he died on 2nd December 2013 following a short illness. He is survived by his sister Ita, his brothers George and John, his daughter Diana, and his grand-daughter Loïs.

Selected publications:

Galletly G.D. and Reynolds, T.E., "A Simple Extension of Southwell's Method for Determining the Elastic General Instability Pressure for Ring-Stiffened Cylinders Subject to External Hydrostatic Pressure", Proceedings of the Society for Experimental Stress Analysis, Vol. 13, No. 2, 141-152, 1956.

Galletly, G. D., and Bart, R., "Effects of Boundary Conditions and Initial Out-of-Roundness on the Strength of Thin-Walled Cylinders Subject to External Hydrostatic Pressure", Journal of Applied Mechanics, Transactions of the American Society of Mechanical Engineers, Vol. 23, September 1956, pp. 351-358.

Galletly GD, Slankard RC, Wenk E Jr (1958) General instability of ring-stiffened cylindrical shells subject to external hydrostatic pressure—A comparison of theory and experiment. J Appl Mech 25:259–266

Galletly, G. D., "Torispherical Shells—A Caution to Designers," ASME Journal for Engineering in Industry, Vol. 81, Feb.1959, pp. 51-66.

G. D. Galletly (1), R. W. Aylward (1) and D. Bushnell (2)
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(2) Lockheed Palo Alto Research Lab
“An experimental and theoretical investigation of elastic and elastic-plastic asymmetric buckling of cylinder-cone combinations subjected to uniform external pressure”, Archive of Applied Mechanics, Vol. 43, No. 6, 1974, pp.345-358, doi: 10.1007/BF00532134
ABSTRACT: Experimental buckling pressures are given in the paper for six cylinder-cone combinations which were carefully machined and stress-relieved and then tested under uniform external pressure. Failure in all cases occurred by asymmetric buckling (i.e. with circumferential waves); although some failures were elastic, others were elastic-plastic. Theoretical buckling pressures for the models (assumed perfect) were obtained from a variational finite-difference formulation of the problem which has been incorporated into a comprehensive digital computer program. The agreement between theory and experiment was very satisfactory and may be summarized as: (i) for elastic buckling, it was within 5% and (ii) for elastic-plastic buckling, it was within 2%. This latter figure is surprisingly good. With regard to the repeatability of experimental results, the tests conducted so far have agreed to within 3%.

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“Comparisons of test and theory for nonsymmetric elastic-plastic buckling of shells of revolution”, International Journal of Solids and Structures, Vol. 10, No. 11, November 1974, pp. 1271-1286, doi:10.1016/0020-7683(74)90072-9
ABSTRACT: Experimental and analytical buckling pressures are presented for very carefully fabricated thin cylindrical shells with 45, 60 and 75° conical heads and for cylindrical shells with torispherical heads pierced by axisymmetric cylindrical nozzles of various thicknesses and diameters. Nonsymmetric buckling occurs at pressures for which some of the material is loading plastically in the neighborhoods of stress concentrations caused by meridional slope discontinuities. The buckling pressures for the cone-cylinder vessels are predicted within 2.6 per cent and for the pierced torispherical vessels within 4.4 per cent with use of BOSOR5, a computer program based on the finite difference energy method in which axisymmetric large deflections, nonlinear material properties and nonsymmetric bifurcation buckling are accounted for. The predicted buckling pressures of the pierced torispherical specimens are rather sensitive to details of the analytical model in the neighborhood of the juncture between the nozzle and the head. The buckling pressures of the cone-cylinder vessels can be accurately predicted by treatment of the wall material as elastic, enforcement of the full compatibility conditions at the juncture in the prebuckling analysis, and release of the rotation compatibility condition in the bifurcation (eigenvalue) analysis.

G.D. Galletly and R.W. Aylward (Applied Mechanics Division, Department of Mechanical Engineering, University of Liverpool, Liverpool, Great Britain), “Buckling under external pressure of cylinders with either torispherical or hemispherical end closures”, International Journal of Pressure Vessels and Piping, Vol. 1, No. 2, April 1973, pp. 139-154, doi:10.1016/0308-0161(73)90019-7

ABSTRACT: In a number of applications, the actual boundary conditions at the ends of a cylinder are not taken into account properly when the structure is being designed against buckling. For example, in the design of submersibles the older theoretical treatments assume that bulkheads are present at the ends of the cylinders, whereas this form of construction is not always used. The purpose of the investigation described here is to study the effect of realistic boundary conditions on the elastic buckling pressure of unstiffened cylinders with torispherical or hemispherical end closures. In the present study only perfect, initially stress-free, structures are considered and their theoretical buckling pressures are obtained from a variational finite-difference program written for the digital computer. The numerical results presented were obtained from a limited parametric survey of the problem. In the main, linear buckling theory was used. However, as is shown, this can sometimes lead to unsafe predictions. The buckling pressures for the cylinders with hemispherical end closures, as predicted by the variational finite-difference technique, are also compared with a modified von Mises formula with corrections for the end closures. The agreement between the two sets of predictions was good within the range of the survey.

R.W. Aylward and G.D. Galletly (Applied Mechanics Division, Department of Mechanical Engineering, University of Liverpool, Liverpool, Great Britain), “Elastic buckling of, and first yielding in, thin torispherical shells subjected to internal pressure”, International Journal of Pressure Vessels and Piping, Vol. 7, No. 5, September 1979, pp. 321-336, doi:10.1016/0308-0161(79)90025-5
ABSTRACT: With the aid of the non-linear shell buckling computer program BOSOR 4, the internal pressures at which elastic circumferential buckling (or wrinkling) take place in thin torispherical shells have been calculated. The maximum equivalent (or effective) stresses in the shells in the axisymmetric pre-buckled state were also obtained…

G D Galletly (Department of Mechanical Engineering, University of Liverpool), “Plastic buckling of torispherical and ellipsoidal shells subjected to internal pressure”, Proceedings of the Institution of Mechanical Engineers 1847-1996, Volume 195 / 1981, pp. 329-345, doi: 10.1243/PIME_PROC_1981_195_034_02
ABSTRACT: Thin metallic torispherical shells are used frequently in many industries as end closures on cylinders subjected to internal pressure and, for those torispheres which have diameter/thickness ratios greater than 400, elastic–plastic internal pressure buckling may occur. As yet, however, code rules to assist the designer with this buckling problem are not available in either the UK or the USA and one of the aims of this paper is to help to correct this situation.Elastic–plastic internal buckling pressures, for a range of perfect torispherical geometries and obtained with the aid of a sophisticated computer program, are given in the first part of the paper. These pcr's are then utilized (a) to develop a relatively simple equation for predicting the internal buckling pressures of torispherical shells and (b) to assess the accuracy of another, even simpler, approximate buckling equation which was suggested recently….

G D Galletly and J Blachut (Department of Mechanical Engineering, University of Liverpool), “Torispherical shells under internal pressure—failure due to asymmetric plastic buckling or axisymmetric yielding”, Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 199, No. C3 / 1985, pp. 225-238, DOI: 10.1243/PIME_PROC_1985_199_117_02
ABSTRACT: In the diameter-to-thickness range $250 < D/t < 1000$, internally pressurized torispherical shells can fail either by plastic buckling or by axisymmetric yielding. However, the present Code rules cater only for the axisymmetric yielding mode and they also restrict the D/t ratios to being less than 500. The rules are based

on limit analysis results and these can be conservative for this problem. With regard to internal pressure buckling, there are as yet no design rules in either the American or the British pressure vessel Codes to prevent its occurrence.To provide guidance for a more accurate formulation of design rules for both of these failure modes over the range 300 < D/t < 1500, the authors have made a series of calculations to determine the values of Pcr (the internal buckling pressure) and Pc (the axisymmetric yielding pressure) for perfect torispherical shells. The availability of these results, obtained with a finite-deflection shell theory, enables curves to be drawn showing when buckling is the controlling failure mode and when axisymmetric yield controls. …

G D Galletly, K Pemsing (Department of Mechanical Engineering, University of Liverpool), "Interactive buckling tests on cylindrical shells subjected to axial compression and external pressure—a comparison of experiment, theory and various codes", Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 199, No. C4, 1985, pp. 259-280, doi: 10.1243/PIME_PROC_1985_199_123_02
ABSTRACT: The buckling of welded steel cylindrical shells under the combined action of external pressure and axial compressive loads is of considerable interest to the offshore oil and nuclear industries. However, test results on this subject are scarce and some design rules which have been proposed recently have not been validated experimentally, especially in the plastic buckling region. In order to check these rules, and suggest others, interactive buckling tests were conducted at Liverpool University on cylindrical shells having R/t "H 100. One series of tests consisted of 19 machined and stress-relieved steel models having L/R ratios of 0.33, 0.74 and 1.45. The results obtained on these near-perfect machined models were compared with theoretical predictions of the behaviour of perfect cylindrical shells and the agreement between the two was good. The other series consisted of 21 welded steel models and had geometric ratios which were similar to the machined ones. The linear interaction equation Sp + Sx = 1 was used to predict the failure loads of these welded steel models and the predictions were safe in all cases. However, for some combined loading cases the linear equation was rather conservative and, in consequence, some non-linear interaction equations were investigated. These seem promising for design purposes. Irrespective of whether a linear or a non-linear equation is chosen for design, more tests will be needed to establish the scatter bands of the interactive buckling curves for various values of R/t.Some tests were also carried out on (a) the effect of the loading path on the failure loads and (b) models with localized dents. Other topics discussed in the paper are: the effects of residual stresses and initial geometric imperfections, the general procedure adopted by Codes to predict buckling loads and some discrepancies between the predictions of various Codes.

G D Galletly (Department of Mechanical Engineering, University of Liverpool), "Design equations for preventing buckling in fabricated torispherical shells subjected to internal pressure", Proceedings of the Institution of Mechanical Engineers 1847-1996, Volume 200, Number A2 / 1986, pp. 127-139,
doi: 10.1243/PIME_PROC_1986_200_018_02
(cannot cut and paste the abstract)

G.D. Galletly (1), J. Blachut (1) and J. Kruzelecki (2)
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(2) Technical University of Krakow, Poland
"Plastic buckling of imperfect hemispherical shells subjected to external pressure", Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 201, No. C3 / 1987, pp. 153-170,
doi: 10.1243/PIME_PROC_1987_201_103_02

ABSTRACT: Plastic buckling/collapse pressures for externally pressurized imperfect hemispherical shells were calculated for several values of the yield point, the radius-thickness ratio, and the amplitude of the initial imperfections at the pole. The well-known elastic-plastic shell buckling program, BOSOR5, was used in the calculations, and two axisymmetric initial imperfection shapes were studied, a localized increased-radius type and a Legendre polynomial….

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(1) Department of Mechanical Engineering, University of Liverpool
(2) Technical University of Krakow, Poland
"Buckling of shallow torispherical domes subjected to external pressure – a comparison of experiment, theory, and design codes", The Journal of Strain Analysis for Engineering Design, Vol. 22, No. 3, 1987, pp. 163-175, doi: 10.1243/03093247V223163
ABSTRACT: The test results obtained on 24 externally-pressurised torispherical steel shells are given in this paper. The knuckle radius-to-diameter ratio of the domes varied from 0.06 to 0.18 and the spherical cap radius-to-thickness ratios were between 75 and 335. Initial shape and thickness measurements were carried out on all the torispheres and a summary of this information is given. The BOSOR5 shell buckling program was employed to predict the buckling/collapse pressures of all the domes; both perfect domes and those with axisymmetric imperfections were considered. The correlation between the theoretical predictions and the experimental results was, in general, very good. The main conclusions of the present investigation are: (i) that some of the experimental buckling pressures were lower than those obtained by multiplying the BS 5500 design values by a safety factor of 1.5, and (ii) that those torispheres with sharp knuckle radii failed by plastic collapse in the knuckle region and the collapse pressures were not very sensitive to initial geometric imperfections. It thus appears that the BS 5500 rules relating to the strength of shallow torispheres subjected to external pressure need to be amended, and that the tolerances on geometric shape for cases which are likely to be imperfection-insensitive should be reconsidered.

G D Galletly and J Blachut (Department of Mechanical Engineering, University of Liverpool), "Elastic buckling of internally pressurized cylinder-bulkhead combinations", Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 201, No. C4, 1987, pp. 259-262,
doi: 10.1243/PIME_PROC_1987_201_118_02
ABSTRACT (cannot cut and paste abstract)

J. Blachut and G. D. Galletly (Department of Mechanical Engineering, University of Liverpool), "Clamped torispherical shells under external pressure – some new results", The Journal of Strain Analysis for Engineering Design, Vol. 23, No. 1,1988, pp. 9-24, doi: 10.1243/03093247V231009
ABSTRACT: Perfect clamped torispherical shells subjected to external pressure are analysed in the paper using the BOSOR5 shell buckling program. Various values of the knuckle radius-to-diameter ratio (r/D) and the spherical cap radius-to-thickness ratio (Rs/t) were studied, as well as four values of sigmayp, the yield point of the material. Buckling/collapse pressures, modes of failure and the development of plastic zones in the shell wall were determined. A simple diagram is presented which enables the failure mode in these shells to be predicted. The collapse pressures, pc, were also plotted against the parameter….

G D Galletly and A Muc (Department of Mechanical Engineering, University of Liverpool), “7Buckling of fibre-reinforced plastic steel torispherical shells under external pressure”, Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 202, No. C6, 1988, pp. 409-420, doi:10.1243/PIME_PROC_1988_202_143_02
ABSTRACT: (cannot cut and paste abstract)

G D Galletly and A Muc (Department of Mechanical Engineering, University of Liverpool), “7Buckling of externally pressurized composite torispherical domes”, Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 203, No. E1, 1989, pp. 41-56, doi: 10.1243/PIME_PROC_1989_203_187_02
ABSTRACT: (cannot cut and paste abstract)

G D Galletly, J Blachut, D N Moreton (Department of Mechanical Engineering, University of Liverpool), “Internally pressurized machined domed ends—a comparison of the plastic buckling predictions of the deformation and flow theories”, Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 204, No. C3, 1990, pp. 169-186, doi: 10.1243/PIME_PROC_1990_204_093_02
ABSTRACT: (cannot cut and paste)

G D Galletly (1), D N Moreton (1), A Muc (2)
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“Buckling of slightly flattened domed ends reinforced locally with fibre-reinforced plastic”7, Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 204, No. E1, 1990, pp. 15-24, doi: 10.1243/PIME_PROC_1990_204_161_02
ABSTRACT: (cannot cut and paste)

G D Galletly and J Blachut (Department of Mechanical Engineering, The University of Liverpool), “7Stability of complete circular and non-circular toroidal shells”, Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 209, No. C4, 1995, pp. 245-255, doi: 10.1243/PIME_PROC_1995_209_151_02
ABSTRACT (cannot cut and paste abstract)

J. Blachut and G. D. Galletly (Department of Mechanical Engineering, University of Liverpool, PO Box 147, Liverpool, UK, L69 3BX), “Buckling strength of imperfect steel hemispheres”, Thin-Walled Structures, Vol. 23, Nos. 1-4, 1995, pp. 1-20, Special Issue: Buckling Strength of Imperfection-sensitive Shells, doi:10.1016/0263-8231(95)00001-T
ABSTRACT: Experimental and numerical results on seven 580 mm diameter, spun steel, hemispherical shells subjected to external pressure are discussed in the paper. The average wall thickness of the shells varied from 0·37mm to 2·5mm. Careful shape and thickness measurements on all the shells were obtained and utilised in several types of analysis (2-D Finite Element, bestfit axisymmetric, axisymmetric with a local fattening, etc.). None of the analysis techniques employed proved to be entirely reliable insofar as predicting the collapse strength of the spun steel hemispheres. For example, the ratios of the experimental to the 2-D FE numerical collapse pressures were between 0·56 and 1·21. The test results were also compared with the ECCS design

curve and it is shown that one should use the minimum shell thickness for design purposes and not rely on the average wall thickness (three test results plotted below the design curve when the average wall thickness was used).

J Blachut, G D Galletly, S James (Department of Mechanical Engineering, The University of Liverpool), "On the plastic buckling paradox for cylindrical shells", Proceedings of the Institution of Mechanical Engineers 1847-1996, Vol. 210, No. C5, 1996, pp. 477-488, doi: 10.1243/PIME_PROC_1996_210_221_02
ABSTRACT: (cannot cut and past abstract)

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"Buckling of complex toroidal shell structures", Thin-Walled Structures, Vol. 26, No. 3, November 1996, pp.195-212, doi:10.1016/0263-8231(96)00023-7
ABSTRACT: A recent innovation in the design of submersibles is the employment of a series of circular pipes to form part of the pressure hull. These pipes serve as storage for gaseous oxygen, which is mixed with fuel oil to drive a diesel engine in a closed-cycle mode. One of the structural design problems with these vessels is the calculation of the local buckling pressure of the hull and in this paper this is tackled by isolating a short section of the vessel. Two adjacent toroids were considered first, together with their connecting annular segments. Then three toroids were considered. The loading was external pressure on the external surface of the vessel plus the axial thrust caused by the pressure on the end closures. The stress distributions, elastic plastic buckling pressures and mode shapes were determined using the variational finite-difference BOSOR5 program. Factors investigated for the 2-torus case were: the shape of the connecting segments, the constraint conditions at the contact point between the toroids and the influence of the yield stress. The results of the investigation showed that: (i) the local buckling pressure of the 3-torus structure was almost the same as that of the 2-torus case; and (ii) cylindrical connecting segments gave a higher buckling pressure than circular toroidal ones. A simple approximate method for calculating the local buckling pressure of the 2-torus shell structure was also checked. It turned out to be conservative, giving a buckling pressure which was about three-quarters of the BOSOR 5 value.

G.D Galletly (Department of Mechanical Engineering The University of Liverpool, Brownlow Street, Liverpool L69 3GH, UK), "Elastic buckling of imperfect circular toroidal shells under external pressure", Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering, Volume 212, No. 3, 1998, pp. 197-209, doi: 10.1243/0954408981529411
ABSTRACT: When perfect, externally pressurized complete circular toroidal shells buckle, the minimum buckling pressure pcr usually occurs in the axisymmetric $n = 0$ mode, with pcr for $n = 2$ being only slightly larger. In the present paper, the effects of axisymmetric initial geometric imperfections on reducing pcr for the perfect shell are investigated. Various types of imperfection are studied, i.e. localized flat spots, smooth dimples, sinusoids and buckling mode shapes. The principal geometry investigated was $R/b = 10$, $b/t = 100$, although other geometries were also considered. The maximum decrease in buckling resistance….

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L69 3GH, UK), “Elastic buckling of complete toroidal shells of elliptical cross-section subjected to uniform internal pressure”, Thin-Walled Structures, Vol. 30, Nos. 1-4, January 1998, pp. 23-34, doi:10.1016/S0263-8231(97)00030-X
ABSTRACT: It was predicted recently that some complete toroidal shells of elliptical cross-section would buckle when subjected to internal pressure. As yet there is no experimental evidence for this, so two independent shell buckling programs (BOSOR and INCA) were employed to calculate the internal buckling pressures for some test cases. The agreement between the results of the two programs is very good, with both programs predicting that buckling occurs. Calculations were also carried out by using BOSOR on complete toroids having cross-sections in the form of prolate ($k=a/b>1.0$) ellipses. The ranges of the parameters were: $R/b=4$ and 10, $b/t=50$, 100 and 200, and $1.3<k<2.5$. The shells were assumed to be perfect, made from steel and to behave elastically. The buckling pressures and circumferential wavenumbers are given in tabular form and some are plotted graphically. The deformed shapes of some typical cross-sections prior to buckling are also illustrated, along with the buckling modes.

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“Plastic buckling of complete toroidal shells of elliptical cross-section subjected to internal pressure”, Thin-Walled Structures, Vol. 34, No. 2, June 1999, pp. 135-146, doi:10.1016/S0263-8231(99)00006-3
ABSTRACT: The plastic bifurcation buckling pressures of 60 internally-pressurised, perfect, complete toroidal shells of elliptical cross-section are given in the present paper, assuming elastic, perfectly plastic, material behaviour. The shell buckling programs employed in the computations were BOSOR 5 and INCA. Denoting the major-to-minor axis ratio by k, the numerical results show that the plastic buckling pressures are considerably lower than their elastic counterparts in the range $1.25 \le k \le 1.5$ and are approximately equal to them for $k=2.5$. A limited study of the effects of non-axisymmetric initial geometric imperfections on the buckling pressures of the shells was also carried out using the INCA code. For the four cases studied the post-buckling behaviour was stable. This means that designers can use the buckling pressures given herein for perfect shells as a basis for their initial designs.

Gerard Galletly as a young professor at the University of Liverpool in the Dept. of Mechanical Engineering