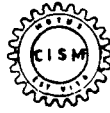


INTERNATIONAL CENTRE FOR MECHANICAL SCIENCES

COURSES AND LECTURES - No. 236



M. ESSLINGER - B. GEIER
INSTITUT FÜR FLUGZEUGBAU
BRAUNSCHWEIG

POSTBUCKLING BEHAVIOR OF STRUCTURES

M

Technische Hochschule Darmstadt
Fachbereich Mechanik
Bibliothek
Inv.-Nr. BM 133/77

SPRINGER - VERLAG



WIEN - NEW YORK

Contents

	page
1. Introduction*	3
2. Plates and foldes structures	10
2.1 Rectangular plates	10
2.1.1 Effective width	10
2.1.2 Experimental investigations of a thin panel	12
2.1.3 Theoretical investigations of a perfect panel	20
2.1.4 Panel as element of a folded structure	24
2.2 Welded box beams	28
2.2.1 Preliminary remarks	28
2.2.2 Experimental investigations	29
2.2.3 Theoretical investigations	38
2.2.4 Comparison with results, obtained for cold formed sections	48
2.3 Open profiles of cold formed steel	49
2.3.1 Preliminary remarks	49
2.3.2 Experimental investigations	49
2.3.3 Theoretical investigations	55
2.4 Arches under bending	60
2.5 Web subjected to shear	62
2.5.1 The tension field	62
2.5.2 The flanges	65
2.5.3 The struts	65
2.5.4 Application	66
2.6 Some remarks on optimization	66
2.6.1 Preliminary remarks	66
2.6.2 Perfect structures	67
2.6.3 Imperfect structures	71
2.6.4 Stability in the initial post-buckling region	75
3. Thin-walled circular cylinders	82
3.1 Isotropic cylinders under external pressure	82
3.1.1 Experimental investigations	82
3.1.2 Theoretical investigations of perfect cylinders	88
3.1.3 Theoretical investigations of imperfect cylinders	91
3.2 Isotropic cylinder under axial load	101
3.2.1 Preliminary remarks	101

	page	
3.2.2	Experimental investigations of stable equilibrium states	102
3.2.3	Theoretical investigations of stable equilibrium states	109
3.2.4	Experimental investigations of disturbed cylinders	116
3.2.5	Experimental investigations of unstable equilibrium states	122
3.2.6	Theoretical investigations of unstable equilibrium states	124
3.2.7	Concluding remarks	130
3.3	Short isotropic cylinder under axial load	132
3.4	Isotropic cylinders under torsion	135
3.5	Orthotropic cylinders	140
3.5.1	Introduction	140
3.5.2	Cylinder under external hydrostatic pressure	144
3.5.3	Cylinder under axial load	148
3.6	Discretely stiffened cylinders	157
3.6.1	Preliminary remarks	157
3.6.2	Axially loaded cylinders	158
3.6.3	Cylinders subjected to external hydrostatic pressure	163
3.7	Isotropic cylinders under combined axial load and internal pressure	169
3.7.1	Experimental investigations	
3.7.2	Theoretical investigations	174
3.8	Isotropic cylinders under combined axial load and external pressure	181
3.8.1	Buckling investigations	181
3.8.2	Postbuckling investigations	181
3.9	Axially loaded cylinders buckling in the plastic region	186
3.9.1	Preliminary remarks	
3.9.2	Circular cylindrical tubes with low yield limit	187
3.9.3	Circular cylindrical tubes with high yield limit	193
3.9.4	Channel section with closing plate	195
4.	Spherical shell	202
4.1	Initial imperfection sensitivity	202
4.2	Complete sphere	204

	page
4.2.1 Test specimens	204
4.2.2 Experimental equipment and procedures	205
4.2.3 Experimental results	208
4.2.4 Theoretical results	216
4.2.5 Discussion of the experimental and theoretical results	220
4.3 Spherical caps	
4.3.1 Buckling investigations	222
4.3.2 Postbuckling investigations	223
5. Analysis	230
5.1 Cylindrical shells	230
5.1.1 Notations	230
5.1.2 Differential equations	233
5.1.3 Survey on some proven solution methods	243
5.1.4 Series expansion	246
5.1.5 Solution of the compatibility condition	251
5.1.6 Solution of the equilibrium condition	254
5.1.7 Shortening and potential energy	256
5.1.8 Execution of calculations	258
5.2 Spherical shells	260
5.2.1 Notations	
5.2.2 Survey	262
5.2.3 Basic equations	263
5.2.4 Compatibility equation	265
5.2.5 Total potential energy	265
5.2.6 Matching conditions	271
5.2.7 Method of solution	271
5.2.8 Numerical results	273