

ISO 23778:2022-09 (E)

Proof of competence of hydraulic cylinders in crane applications

Contents	Page
Foreword	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols	2
5 General	3
5.1 Documentation	3
5.2 Materials for hydraulic cylinders	5
5.2.1 General requirements	5
5.2.2 Grades and qualities	6
6 Proof of static strength	7
6.1 General	7
6.2 Limit design stresses	8
6.2.1 General	8
6.2.2 Limit design stress in structural members	8
6.2.3 Limit design stresses in welded connections	9
6.3 Linear stress analysis	9
6.3.1 General	9
6.3.2 Typical cylinder arrangements	9
6.3.3 Cylinder tube	11
6.3.4 Cylinder bottom	13
6.3.5 Piston rod welds	14
6.3.6 Cylinder tube and piston rod threads	14
6.3.7 Thread undercuts and locking wire grooves	14
6.3.8 Oil connector welds	15
6.3.9 Connecting interfaces to crane structure	16
6.4 Nonlinear stress analysis	16
6.4.1 General	16
6.4.2 Standard cylinder with end moments	16
6.4.3 Support leg	16
6.5 Execution of the proof	17
6.5.1 Proof for load bearing components	17
6.5.2 Proof for bolted connections	17
6.5.3 Proof for welded connections	18
7 Proof of fatigue strength	18
7.1 General	18
7.2 Stress histories	18
7.3 Execution of the proof	20
7.4 Limit design stress range	20
7.5 Details for consideration	20
7.5.1 General	20
7.5.2 Bottom weld	20
7.5.3 Notch stress at oil connectors	23
7.5.4 Cylinder head	24
7.5.5 Piston rod	26

7.5.6	Cylinder head bolts	28
7.5.7	Cylinder head flange weld	28
7.5.8	Mechanical interfaces	30
8	Proof of elastic stability	30
8.1	General	30
8.2	Critical buckling load	30
8.3	Limit compressive design force	32
8.4	Execution of the proof	33
	Annex A (informative) Critical buckling load for common buckling cases	34
	Annex B (informative) Second order analysis of two important cases	38
	Annex C (informative) Shell section forces and moments for cylinder bottom	41
	Annex D (informative) Fatigue analysis of bottom weld for more complex cases	44
	Bibliography	47