TECHNICAL SPECIFICATION

First edition

Cranes — Safe use of highperformance fibre ropes in crane applications

Appareils de levage a charge suspendue — Utilisation en sécurité des câbles synthétiques haute performance pour les applications sur les appareils de levage à charge suspendue

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO/PRF TS 23624 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-66d394b05344/iso-prf-ts-23624

PROOF/ÉPREUVE



Reference number ISO/TS 23624:2021(E)

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO/PRF TS 23624 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-66d394b05344/iso-prf-ts-23624



COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office CP 401 • Ch. de Blandonnet 8 CH-1214 Vernier, Geneva Phone: +41 22 749 01 11 Email: copyright@iso.org Website: www.iso.org

Published in Switzerland

Contents

Page

Introduction vi 1 Scope 1 2 Normative references 1 3 Terms and definitions 1 4 HPFR performance considerations 3 4.1 Responsibilities 3 4.2 Risk assessment 3 4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 4 4.3.2 Selection of ropes 7 5 Grane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3.3 Drum 9 5.3.4 Clearance between rope and diameters of drum flange 10 5.3.4 Clearance between rope and diameters of drum flange 10 5.4 Shaves 10 5.5.1 Contact surfaces 11 5.5 Crane of service store	Forev	word		v			
2 Normative references 1 3 Terms and definitions 1 4 HPFR performance considerations 3 4.1 Responsibilities 3 4.2 Risk assessment 3 4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3.3 Drum 9 5.3.4 Clearance between one and diameter of drum flange 10 5.4 Clearance between one and diameter of drum flange 10 5.3.5 Temperature fluits 10 5.4 Shape of grooves in Context surfaces 11 5.5 Crane 10 5.4.1 Shape of starder's standard's stardood-oded-1244-8900 10 5.5 Crane 11 5.5.2 5.6	Intro	ductio	1	vi			
3 Terms and definitions 1 4 HPFR performance considerations 3 4.1 Responsibilities 3 4.2 Risk assessment 3 4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4.4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3.1 Lowering limiter 9 5.3.2 Forces on flange and tube (Multilaper drum) 9 5.3.3 Shape of grooves on drums 10 5.4 Shape of grooves is on drums 10 5.4.3 Marterial of sharely standarkstac Stobood code 4:244-89:0- 10 5.4.1 Shape of grooves is COPPUT IS 2:624 10 5.4.2 Hoares 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.2 <t< td=""><td>1</td><td>Scope</td><td>9</td><td></td></t<>	1	Scope	9				
4 HPFR performance considerations 3 4.1 Responsibilities 3 4.2 Risk assessment 3 4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4.4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3 Drum 9 5.3.4 Clearance between rope and diameter of drum flange 10 5.3.5 Termperature limits 10 5.4.1 Shape of grooves SOPPCT IS 27624 10 5.4.3 Minimum D/d Tatio 05144 worp files 2024 10 5.4.4 Shape of grooves SOPPCT IS 27624 10 5.4.5 Shape of grooves SOPPCT IS 27624 10 5.4.4 Shape of grooves SOPPCT IS 27624 10 5.5 Crane 11 5.5 5.6 Crane	2	Norm	native references				
4 HPFR performance considerations 3 4.1 Responsibilities 3 4.2 Risk assessment 3 4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4.4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3 Drum 9 5.3.4 Clearance between rope and diameter of drum flange 10 5.3.5 Termperature limits 10 5.4.1 Shape of grooves SOPPCT IS 27624 10 5.4.3 Minimum D/d Tatio 05144 worp files 2024 10 5.4.4 Shape of grooves SOPPCT IS 27624 10 5.4.5 Shape of grooves SOPPCT IS 27624 10 5.4.4 Shape of grooves SOPPCT IS 27624 10 5.5 Crane 11 5.5 5.6 Crane	3	Term	s and definitions				
4.1 Responsibilities 3 4.2 Risk assessment 3 4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4.4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination on the drum 9 5.3.1 Lowering limiter 9 5.3.2 Forego on flage and tube (Multilayer drum) EW 9 5.3.3 Shape of grooves on drums 10 5.4.4 Shaaves 10 5.4.5 Shave of grooves standards stractober dead dameter of drum flage 10 5.4.1 Shave of grooves standards stractober dead 4244 stractober de	4						
4.3 Rope 4 4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4.4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3.3 Shape of grooves on drums 9 5.3.4 Clearance between tope and diameter of drum flange 10 5.3.5 Temperature limits 10 5.4 Sheeves 10 5.4 Sheaves 10 5.4 Sheaves 10 5.4.1 Shape of grooves of drums 10 5.4.2 Termperature limits 10 5.4.3 Minimum D/d ratio 05144 so-prts-23624 10 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 <t< td=""><td>•</td><td></td><td>Responsibilities</td><td></td></t<>	•		Responsibilities				
4.3.1 Types of ropes 4 4.3.2 Selection of ropes 5 4.4 Proof of competence 7 4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination on the drum 9 5.3.1 Lowering limiter 9 5.3.2 Forces on flange and the (Multilayer drum) 9 5.3.3 Shape of grooves on drums 10 5.3.4 Clearance between tope and diameter of drum flange 10 5.3.4 Clearance between tope and diameter of drum flange 10 5.4.3 Shape of grooves SOPRC TN 23624 10 5.4.3 Shape of grooves SOPRC TN 23624 10 5.4.4 Shaves 10 5.4.2 10 5.4.3 Minimum D/d Tatlo '5344'so- prEx-23624 10 5.5.4 10 5.5.5 Crane 11 5.5.2 Fleet angles 11 5.5.4 Substitution on existing design and optimization on new designs11 5.5.4 Substitution on used cran							
4.3.2 Selection of ropes 5 4.4 Proof of competence. 7 4.5 Safety factor at discard for HPFR. 7 5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3 Drum 9 5.3.1 Lowering limiter 9 5.3.2 Forces on fange and tube (Multilayer drum) FW 9 5.3.3 Shape of grooves on drums 10 5.4.1 Shape of grooves in drums 10 5.4.1 Shape of grooves ison drums 10 5.4.2 Temperature fimits 10 5.5.4 Shape of grooves ison drums 10 5.4.3 Minitum D/d ratio ¹⁰⁵³⁴⁴ resolves ison docid-dcad-4244-890 10 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and		4.3					
4.4Proof of competence74.5Safety factor at discard for HPFR75Crane design considerations85.1Termination on the drum85.2Termination at load side95.3Drum95.3.1Lowering limiter95.3.2Forces, on flange and tube (Multilayer drum)95.3.3Shape of grooves on drunge and diameter of drum flange105.4Clearance between rope and diameter of drum flange105.4.3Shape of grooves in drunge and visit diameter of drum flange105.4.4Shape of grooves in drunge and visit diameter of drum flange105.4.5Sheaves105.4.1Shape of grooves in drunge standards/sistac800b60-dcad-4244-89a9105.4.3Minimum D/d ratio344 sep ref.ts-23624105.5Crane115.5.1Contact surfaces115.5.2Fleet angles115.5.3Substitution on used cranes116Qualification testing of HPFR116.1General126.2.1General126.3.1General126.3.3Multilayer spooling strength, MBS126.3.4General126.3.4General126.3.1General126.3.1General126.3.2Residual breaking strength, RBS126.3.3Multilayer spooling performance136.3.4							
4.5 Safety factor at discard for HPFR 7 5 Crane design considerations 8 5.1 Termination at load side 9 5.3 Drum 9 5.3.1 Lowering limiter 9 5.3.2 Forces on flange and tube (Multilayer drum) EW 9 5.3.3 Shape of grooves of drums 10 5.3.4 Clearance between rope and diameter of drum flange 10 5.4.1 Shape of grooves is 00-PRF TS 23624 10 5.4.1 Shape of grooves is 00-PRF TS 23624 10 5.4.1 Shape of grooves is standards state 806b60-dcad 4244-890- 10 5.4.2 Shaeves 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 Qualification testing of HPFR 11 6.1 General 12 6.2.1 General 12 6.2.2 Residual breaking strength, RBS 12 6.3.4<		1 1	1				
5 Crane design considerations 8 5.1 Termination on the drum 8 5.2 Termination at load side 9 5.3 Drum 9 5.3.1 Lowering limiter 9 5.3.2 Forces on flange and tube (Multilayer drum) E-W 9 5.3.3 Shape of grooves on drums 10 5.4.4 Clearance between rone and diameter of drum flange 10 5.4.5 Temperature limits 10 5.4.5 Temperature limits 10 5.4.5 Temperature limits 10 5.4.5 Sheaves 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on used cranes 11 6.4 General 12 6.2.1 General							
5.1 Termination on the drum. 8 5.2 Termination at load side. 9 5.3 Drum. 9 5.3.1 Lowering limiter 9 5.3.2 Forces on finange and tube (Multilayer drum) EW 9 5.3.3 Shape of grooves of drums 10 5.4 Clearance between tope and diameter of drum flange 10 5.4.1 Shape of grooves <u>ISOPRF TS 23024</u> 10 5.4.1 Shape of grooves <u>ISOPRF TS 23024</u> 10 5.4.1 Shape of sheave grandardsistacs06660-dcad-4244-89a9 10 5.4.2 Shape of sheave grandardsistacs06660-dcad-4244-89a9 10 5.4.3 Minimum <i>D/d</i> Tatito0344/so-prEts-23024 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12	F						
5.2 Termination at load side 9 5.3 Drum 9 5.3.1 Lowering limiter 9 5.3.2 Forces on flange and tube (Multilayer drum) E.W 9 5.3.3 Shape of grooves on drums 10 5.3.4 Clearance between rope and diameter of drum flange 10 5.4 Shape of grooves ISO/PRE TS 24624 10 5.4 Shape of grooves ISO/PRE TS 24624 10 5.4.1 Shape of grooves ISO/PRE TS 24624 10 5.4.2 Shaves 10 5.4.3 Minimum D/d Tatio ^{05344/so-prE-ts-23624} 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.4 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 11 6.2 Residual breaking strength, MBS 12 6.2.1 General 12 6.3.1 General 12 6.3.2 Bending fatigue performance 12<	3		0				
5.3 Drum 9 5.3.1 Lowering limiter 9 5.3.2 Forces on flange and tube (Multilayer drum) E.W 9 5.3.3 Shape of grooves on drums 10 5.3.4 Clearance between rope and diameter of drum flange 10 5.4.3 Sheaves 10 5.4 Sheaves 10 5.4.1 Shape of grooves (StorMet TS 23624) 10 5.4.2 Material of sheave estandards/sist/ac806660-dcad-4244-89a9 10 5.4.3 Minimum D/d ratio/05344/so-prf.ts-23624 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.4 Substitution on existing design and optimization on new designs 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.1 General 12 6.3.2 Residual breaking strength, MBS 12 6.3.3 Multilayer spooling performance 13 6.3.4 Residual breaking strength, RBS 12 6.3.2 Bending fatigue pe							
5.3.1 Lowering limiter 9 5.3.2 Forces on flange and tube (Multilayer drum) 9 5.3.3 Shape of grooves or drums 10 5.3.4 Clearance between rope and diameter of drum flange 10 5.4.3 Shape of grooves iso PRE TS 23624 10 5.4.1 Shape of grooves iso PRE TS 23624 10 5.4.1 Shape of grooves iso PRE TS 23624 10 5.4.3 Minimum D/d ratio 5344/so-prE = 23624 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on susting design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 11 6.1 General 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigu							
5.3.4 Clearance between rope and diameter of drum flange 10 5.3.5 Temperature limits 10 5.4 Sheaves 10 5.4.1 Shape of grooves ISO/PRE TS 23624 10 5.4.2 Minimum D/d Tatilo 5344/sco-prt IS 23624 10 5.4.3 Minimum D/d Tatilo 5344/sco-prt IS 23624 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 11 6.2 Basic data of HPFR 11 6.1 General 12 6.2.3 Residual breaking strength, MBS 12 6.2.4 Residual breaking strength, RBS 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multiver spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termin			5.3.1 Lowering limiter	9			
5.3.4 Clearance between rope and diameter of drum flange 10 5.3.5 Temperature limits 10 5.4 Sheaves 10 5.4.1 Shape of grooves ISO/PRE TS 23624 10 5.4.2 Minimum D/d Tatilo 5344/sco-prt IS 23624 10 5.4.3 Minimum D/d Tatilo 5344/sco-prt IS 23624 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 11 6.2 Basic data of HPFR 11 6.1 General 12 6.2.3 Residual breaking strength, MBS 12 6.2.4 Residual breaking strength, RBS 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multiver spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termin			5.3.2 Forces on flange and tube (Multilayer drum)	9			
5.4 Sheaves 10 5.4.1 Shape of grooves ISO/PRE IS 23624 10 5.4.2 Wip-Material of sheave gstandards/strace00b60-dcad-4244-89a9- 10 5.4.3 Minimum D/d Tatto 15344/ hor-prite-23624 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual breaking strength, RBS 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection <td></td> <td></td> <td>5.3.3 Shape of grooves on drums</td> <td></td>			5.3.3 Shape of grooves on drums				
5.4 Sheaves 10 5.4.1 Shape of grooves ISO/PRE IS 23624 10 5.4.2 Wip-Material of sheave gstandards/strace00b60-dcad-4244-89a9- 10 5.4.3 Minimum D/d Tatto 15344/ hor-prite-23624 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual breaking strength, RBS 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection <td></td> <td></td> <td>5.3.4 Clearance between rope and chameter of drum flange</td> <td>10</td>			5.3.4 Clearance between rope and chameter of drum flange	10			
5.4.1 Shape of grooves (SOPRE IS 23624 10 5.4.2 Minimum D/d ratio (Sistica 80060- dcad-4244-89a9-) 10 5.4.3 Minimum D/d ratio (Sistica 80060- dcad-4244-89a9-) 10 5.5 Crane 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 Qualification testing of HPFR 11 6.1 General 11 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual breaking strength, RBS 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection 14 7.1 Gen		54	Chanvag	10			
5.5 Crane. 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 Qualification testing of HPFR 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual lifetime 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection 14 7.1 General 14 7.2 Running ropes 14 7.3 Maintenance 14		5.1	5.4.1 Shape of grooves <u>ISO/PRF TS 23624</u>	10			
5.5 Crane. 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 Qualification testing of HPFR 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual lifetime 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection 14 7.1 General 14 7.2 Running ropes 14 7.3 Maintenance 14			5.4.2https//tatelaris of shicatelog/standards/sist/ac806b60-dcad-4244-89a9-				
5.5 Crane. 11 5.5.1 Contact surfaces 11 5.5.2 Fleet angles 11 5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 Qualification testing of HPFR 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual lifetime 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection 14 7.1 General 14 7.2 Running ropes 14 7.3 Maintenance 14			5.4.3 Minimum D/a Tatio ^{05344/iso-prf-ts-23624}				
5.5.2Fleet angles115.5.3Substitution on existing design and optimization on new designs115.5.4Substitution on used cranes116Qualification testing of HPFR116.1General116.2Basic data of HPFR126.2.1General126.2.2Minimum breaking strength, MBS126.2.3Residual breaking strength, RBS126.2.4Residual breaking strength, RBS126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance15		5.5	Crane				
5.5.3 Substitution on existing design and optimization on new designs 11 5.5.4 Substitution on used cranes 11 6 Qualification testing of HPFR 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual lifetime 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance (rope and termination) 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information of test results 14 7.1 General 14 7.2 Installation of HPFR 14 7.2.1 Stationary ropes 14 7.2 Running ropes 14 7.3 Maintenance 15							
5.5.4Substitution on used cranes116Qualification testing of HPFR116.1General116.2Basic data of HPFR126.2.1General126.2.2Minimum breaking strength, MBS126.2.3Residual breaking strength, RBS126.2.4Residual lifetime126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance (rope and termination)136.3.4Tension fatigue performance (Static)147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance147.3Maintenance14							
6 Qualification testing of HPFR 11 6.1 General 11 6.2 Basic data of HPFR 12 6.2.1 General 12 6.2.2 Minimum breaking strength, MBS 12 6.2.3 Residual breaking strength, RBS 12 6.2.4 Residual lifetime 12 6.3 Qualification testing 12 6.3.1 General 12 6.3.2 Bending fatigue performance 13 6.3.3 Multilayer spooling performance 13 6.3.4 Tension fatigue performance (rope and termination) 13 6.3.5 Termination performance (Static) 14 7 Information to be provided regarding care, maintenance and inspection 14 7.1 General 14 7.2 Installation of HPFR 14 7.2.1 Stationary ropes 14 7.3 Maintenance 15							
6.1General116.2Basic data of HPFR126.2.1General126.2.2Minimum breaking strength, MBS126.2.3Residual breaking strength, RBS126.2.4Residual lifetime126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance (rope and termination)136.3.4Tension fatigue performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.2.1Stationary ropes147.3Maintenance15	6	Quali					
6.2Basic data of HPFR126.2.1General126.2.2Minimum breaking strength, MBS126.2.3Residual breaking strength, RBS126.2.4Residual lifetime126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance (rope and termination)136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.2Running ropes147.3Maintenance15	0	-					
6.2.1General126.2.2Minimum breaking strength, MBS126.2.3Residual breaking strength, RBS126.2.4Residual lifetime126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance (rope and termination)136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.2.1Stationary ropes147.3Maintenance15							
6.2.3Residual breaking strength, RBS126.2.4Residual lifetime126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance15			6.2.1 General				
6.2.4Residual lifetime126.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance15							
6.3Qualification testing126.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.2Running ropes147.3Maintenance15							
6.3.1General126.3.2Bending fatigue performance136.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance15		()					
6.3.2Bending fatigue performance136.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance15		6.3					
6.3.3Multilayer spooling performance136.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance14							
6.3.4Tension fatigue performance (rope and termination)136.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.3Maintenance15							
6.3.5Termination performance (Static)146.4Interpolation of test results147Information to be provided regarding care, maintenance and inspection147.1General147.2Installation of HPFR147.2.1Stationary ropes147.2.2Running ropes147.3Maintenance15							
7 Information to be provided regarding care, maintenance and inspection 14 7.1 General 14 7.2 Installation of HPFR 14 7.2.1 Stationary ropes 14 7.2.2 Running ropes 14 7.3 Maintenance 15			6.3.5 Termination performance (Static)	14			
7.1General147.2Installation of HPFR147.2.1Stationary ropes147.2.2Running ropes147.3Maintenance15		6.4	Interpolation of test results				
7.2Installation of HPFR147.2.1Stationary ropes147.2.2Running ropes147.3Maintenance15	7	Infor	mation to be provided regarding care, maintenance and inspection				
7.2.1Stationary ropes147.2.2Running ropes147.3Maintenance15							
7.2.2Running ropes147.3Maintenance15		7.2					
7.3 Maintenance 15							
		72	- 0 -F				
		1.5	7.3.1 Maintenance of the rope				

	7.3.2 Maintenance of rope-related parts of the crane	15				
7.4	Inspection					
7.5	Discard criteria	15				
Annex A (normative) Selection of ropes 18						
Annex B (informative) Qualification testing 22						
Annex C (informative) HPFR test report – Spreadsheet 28						
Annex D (informative) Example of discard						
7.4Inspection157.5Discard criteria15Annex A (normative) Selection of ropes18Annex B (informative) Qualification testing22Annex C (informative) HPFR test report - Spreadsheet28						

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO/PRF TS 23624 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-66d394b05344/iso-prf-ts-23624

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 96, Cranes, SC 3 Selection of ropes.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Recent developments of high-performance fibre ropes (HPFR) made from synthetic fibre have led to comparable strength with regard to steel wire ropes. The main advantages of using HPFR on cranes are:

- a) light weight (significant weight reduction);
- b) no environment pollution by grease (no re-lubrication);
- c) easy handling (faster and easier assembly/disassembly);
- d) robust spooling (increased tolerance for spooling failures).

The use of HPFR on cranes has already started, however, there is limited experience with HPFR in comparison to the long-term application of steel wire ropes.

For steel wire ropes, substantial experience over many decades covering both rope selection and discard criteria exists, which can be found in International Standards (e.g. ISO 16625 and ISO 4309). Currently, there is no standard available that deals with design and discard criteria for the use of HPFR on cranes. Therefore, this document has been developed based on the content of the FEM 5.024 guideline.

The FEM 5.024 guideline was developed by the Fédération Européenne de la Manutention (FEM) as a joint project with various stakeholders in the industry. It is based on first experiences with mobile cranes and the requirements/limits in some cases can be specific to mobile cranes only.

This document includes additional input from tower crane and electric overhead traveling crane manufacturers. Adaptation to other crane types or applications can be necessary.

This document reflects the current knowledge about the use of HPFR on cranes.

ISO/PRF TS 23624 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-66d394b05344/iso-prf-ts-23624

Cranes — Safe use of high-performance fibre ropes in crane applications

1 Scope

This document gives guidance for the safe use of high-performance fibre ropes (HPFR) in crane applications.

This document also covers winch applications. The mention of crane applications implicitly includes winch applications.

This document covers performance criteria and the necessary evaluation to enable selection of HPFR as well as best practice guidelines on procedures, testing and maintenance to safely operate HPFR in crane applications including provisions for assembly/disassembly.

The performance criteria are related to tasks performed when using cranes as intended, including assembly/disassembly, operation and required checks and maintenance.

This document does not deal with so-called hybrid ropes which are a combination of steel wire and high-performance fibres, where the load bearing capability is shared between steel wires and the high-performance fibre. This document does not deal with HPFR used for high risk applications (e.g. transport of hot molten metal).

(standards.iteh.ai)

2 Normative references

<u>ISO/PRF TS 23624</u>

The following documents are referred to in the text in such a way that some or all their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2307:2019, Fibre ropes — Determination of certain physical and mechanical properties

ISO 4309:2017, Cranes — Wire ropes — Care and maintenance, inspection and discard

ISO 9554:2019, Fibre ropes — General specifications

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <u>https://www.iso.org/obp</u>
- IEC Electropedia: available at <u>https://www.electropedia.org/</u>

3.1

assembly/disassembly

all operations needed to set up/down a crane in a specific configuration or change the configuration

3.2

competent person

designated person, suitably qualified by knowledge and experience, and with the necessary instruction to ensure that the required operations are carried out correctly

3.3

cyclic bending over sheave

CBOS

condition where a section of rope experiences a repeated straight-bent-straight change of curvature onto and off a sheave or roller

Note 1 to entry: In a CBOS test, the fibre rope runs around at least one test sheave. A rope pulling force is applied via an appropriate system. During the test, the rope is running in a constant manner on and off the sheave, taking the condition straight-bent-straight. A movement straight-bent-straight over a test sheave counts as one bending cycle for the rope.

3.4

efficiency factor

loss of rope force of a *high-performance fibre rope* (3.5) when bent over sheaves, resulting in rope pull differences

3.5

high-performance fibre rope

HPFR

rope based on high-performance fibres, with a high tensile strength, high modulus and low elongation at break

Note 1 to entry: These fibre ropes have mechanical characteristics in the range of steel wire with regard to strength per area, axial stiffness and elongation at break [e.g. aromatic polyamid (aramid), high modulus polyethylene (HMPE), liquid crystal polymer (LCP), see <u>4.3.1</u>].

3.6

maximum rope pull

MRP

iTeh STANDARD PREVIEW

(standards.iteh.ai)

maximum force applied to the rope during design [of the *rope drive* (3.13)], taking into account dynamic effects, efficiency of the rope drive, reeving, spi**lead**, etc., during operation

https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-

66d394b05344/iso-prf-ts-23624

3.7 minimum breaking strength

MBS

minimum force achieved by a new rope when tested in accordance with a recognized procedure/ test method

3.8

point of discard

point where the tested failure or wear criterion is achieved considering the *residual lifetime* (3.10)

3.9

residual breaking strength

RBS

force a used fibre rope achieves at a point in time when tested according to a recognized procedure/ test method

3.10

residual lifetime

remaining lifetime at a point in time, where the attested failure criterion is not yet fully achieved

3.11

actual rope diameter

 $d_{\rm act}$

diameter of the circle circumscribed about the cross-section of the rope, usually measured under a given tension and method

[SOURCE: ISO 1968:2004, 5.1.10]

3.12 nominal rope diameter

d

reference value for the diameter of a given *high-performance fibre rope* (3.5)

[SOURCE: ISO 1968:2004, 5.1.11]

3.13

rope drive

reeving system according to ISO 4306-1, including the drum (actuator) or other actuators, e.g. cylinders or traction systems

3.14

rope safety factor

n

ratio between breaking strength of the rope and the *maximum rope pull* (3.6)

3.15

termination

means of connecting the *high-performance fibre rope* (3.5) to load bearing parts (e.g. crane, winch, hook)

3.16

torsional stiffness

ability of the *high-performance fibre rope* (3.5) to resist externally induced twist

4 HPFR performance considerations PREVIEW

(standards.iteh.ai)

4.1 Responsibilities

Where a HPFR is installed in a new crane, the crane manufacturer is responsible for the rope drive design, selection of the rope and instructions for use and maintenance.

The rope manufacturer is responsible for providing correct and complete information regarding the rope characteristics and providing information regarding maintenance and inspection of the rope in use.

When a steel wire rope originally installed in a crane is intended to be replaced by a HPFR, an evaluation of the crane design in general and the rope drive components shall be performed by the crane user, with the support and approval of the crane manufacturer, to ensure that all the provisions given by the HPFR manufacturer and this document are fulfilled. The same principle applies when an existing HPFR is replaced by another type of HPFR. The crane user is responsible for ensuring that the crane is used and maintained as instructed.

4.2 Risk assessment

Prior to approval for use of HPFR on a crane application, a risk assessment considering the intended use and any reasonably foreseeable misuse shall be carried out by the manufacturer of the crane application, identifying potential risks that can impact the safety of the rope in operation (see ISO 12100:2010).

The risk assessment should cover the entire life cycle of the rope including installation, maintenance, storage and disposal, rope drive, potential environmental conditions and specifics of the application, including all reasonably expected risks of contact with objects external to the crane. This document shall be reviewed jointly by both the rope manufacturer and the crane application manufacturer (or other applicants), in order to identify potential operational and system risks that can affect the safety of operation. Critical interactions during operation between the rope drive system and HPFR identified in this analysis shall be documented in the technical files to ensure they are in line with the requirements of this document and provide suitable safety as determined for mitigation in the risk assessment process.

Qualification testing of the HPFR shall cover identified critical wear modes to validate that discard criteria provide the required safety factor. The safety factor shall take into account residual breaking strength (RBS) in relation to maximum rope pull (MRP) and residual lifetime required at discard condition of the HPFR.

Where either the HPFR or the rope drive system is intended to change, the risk assessment shall be reviewed to ensure that critical safety considerations are not changed.

The limits of the machinery and the remaining residual risks, which can result from the risk assessment analysis, shall be added in the crane's manual.

4.3 Rope

4.3.1 Types of ropes

The base element of a HPFR is the load bearing fibre. There is a variety of high-performance fibres available to rope manufacturers, each with different attributes that affect characteristics of the final rope. Typical materials utilized in HPFR design include amongst others:

- a) aromatic polyamide (para aramid);
- b) high modulus polyethylene (HMPE);
- c) polyarylate (liquid crystal polymer, LCP);

d) polybenzoxazole (PBO). **iTeh STANDARD PREVIEW**

The high-performance fibre is selected **by the tope manufacturer b**ased on specific characteristics inherent to the material including:

a) tensile strength;

ISO/PRF TS 23624 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9ss): 66d394b05344/iso-prf-ts-23624

- b) modulus (axial stiffness);
- c) elongation at break;
- d) creep characteristics (if applicable);
- e) fatigue resistance (bending and tension);
- f) coefficient of friction;
- g) linear density;
- h) environmental resistances [for details see <u>4.3.2.2</u> j)].

For further information, see ISO 9554:2019, Table A.1.

The high-performance fibres are combined into larger structures through a process such as twisting, braiding, winding or a combination of these or other methods. The design of HPFR construction has a significant impact on the performance of the rope.

Traditional fibres such as polyester, polyamide or polypropylene may be utilized in non-load bearing structures [e.g. protective covers (jackets), stabilizing cores].

Coatings and other non-fibrous materials may be incorporated into the construction of a HPFR in order to achieve various performance characteristics.

Various rope constructions can be utilized in the design of a rope. Several common examples are shown in <u>Figure 1</u>:

— laid in <u>Figure 1 a</u>);

- braided in <u>Figure 1 b</u>);
- cover (jacket over braided rope) in Figure 1 c);
- cover (jacket over parallel fibre) in <u>Figure 1 d</u>).

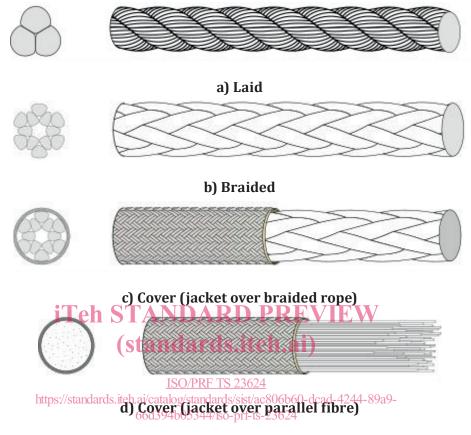


Figure 1 — Common rope construction examples

4.3.2 Selection of ropes

4.3.2.1 General

Hoist ropes shall be selected individually for each particular application and shall be made of suitable materials so that they withstand the intended use. They shall be designed for a period of use, which shall be at least twice the inspection interval, as specified by the crane manufacturer.

The fibre, rope construction and coatings utilized in the design of a HPFR, as well as the design of the rope drive, impact the performance of the HPFR in a given application. Selection of a suitable HPFR shall be the responsibility of the crane manufacturer supported by the rope manufacturer, taking into consideration the potential operational and system risks of the particular crane application including the items listed in 4.3.2.2 and 4.3.2.3.

The HPFR discard criteria as per examples shown in <u>Annex D</u> shall be provided by the rope manufacturer and shall be provided in the manual of the crane.

Where HPFR is used in static (e.g. pendants) or semi-static applications, the rope manufacturer and crane manufacturer shall agree on designed lifetime and discard criteria, specifically in consideration of creep elongation, creep rupture, tension-fatigue and dampening.

The list of items given in 4.3.2.2 and 4.3.2.3 is not exhaustive. Additional items given in Annex A shall be fulfilled.

NOTE Many of the properties listed do not have standard test methods available. The rope manufacturer needs to show how these properties were determined.

4.3.2.2 Rope characteristics

The rope characteristics shall be provided by the rope manufacturer. The rope characteristics shall include the standard or test method used to determine each characteristic.

- a) Rope basic characteristics:
 - nominal rope diameter
 - actual rope diameter (initial and in service including tolerances and measurement method);
 - length (initial and in service including tolerances);
 - rope weight (per metre);
- b) efficiency factor;
- c) abrasion resistance;
- d) resistance to particle ingress;
- e) cut resistance;
- f) coefficient of friction;

iTeh STANDARD PREVIEW (standards.iteh.ai)

g) fatigue characteristics:

ISO/PRF TS 23624

- bending fatigue;
 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-66d394b05344/iso-prf-ts-23624
- tension-tension fatigue;
- h) load elongation characteristics:
 - elongation;
 - stiffness (axial, transverse);
 - creep;
- i) terminations (see <u>5.1</u> and <u>5.2</u>):
 - installation methods;
 - fatigue characteristics;
- j) environmental resistance:
 - temperature;
 - chemical;
 - ultraviolet radiation (UV);
 - weathering;
- k) discard criteria;
- l) rope minimum breaking strength (MBS);

- m) twist performance:
 - tension-torsion coupling;
 - torsional stiffness.

4.3.2.3 Rope drive characteristics

The rope drive characteristics are the responsibility of the crane application manufacturer.

- a) Maximum rope pull (MRP);
- b) fleet angles;
- c) in-service, out of service and storage temperatures;
- d) service intervals;
- e) efficiency of the rope drive system;
- f) sheave, block and drum design:
 - roughness;
 - corrosion resistance,
 - diameter ratio
 Teh STANDARD PREVIEW
 - groove profile and system; (standards.iteh.ai)
 - spooling performance (including pre-tensioning, rope pull etc.);
 - ISO/PRF TS 23624
 - material; https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-
- g) classification (according to ISO 430 41):344/iso-prf-ts-23624
 - U-class (total numbers of working cycles),
 - Q-class (load spectrum);
 - D-class (average displacement of load);
- h) average load movements (displacements).

4.4 **Proof of competence**

The rope drive design shall assure sufficient safety margins on strength and service life until discard for a given application of a crane. This shall be achieved by the following requirements:

- a) the HPFR shall be selected according to the criteria given in <u>4.3.2</u>; and
- b) the competence of the rope drive design shall be determined by a proof of competence, including proof of static strength and proof of fatigue strength of the HPFR.

This is achieved by a qualification test (see 6.3).

4.5 Safety factor at discard for HPFR

Selection of an appropriate HPFR for specific applications shall take into account a rope safety factor at discard when assessing suitability for the required lifetime (design lifetime) and specified inspection frequency.

The safety factor at discard for HPFR shall be determined by the crane manufacturer, considering performance data from the rope manufacturer and the results of the risk assessment, to ensure a sufficient safety margin for residual breaking strength and a sufficient residual lifetime at discard. Inspection intervals of the HPFR drive and in particular of the HPFR shall be determined with regard to the degradation of the rope during use.

The minimum safety factor at discard, expressed as the ratio of RBS at discard and MRP, and the ratio of residual lifetime and total lifetime shall be taken from <u>Table 1</u> and <u>Table 2</u> for various crane types (see also <u>6.3</u> and <u>7.5</u>).

Table 1 — Minimum HPFR safety factors for running ropes at discard for various crane types

Crane types	Safety factor at discard n	Residual lifetime at discard
		%
Winches for pulling purpose only	2,4	60
Hoists (including winches for lifting)	3,0	60
Mobile cranes	3,0	60
Tower cranes	3,0	60
Bridge and gantry cranes	3,0	60

Table 2 — min. HPFR safety factors for stationary ropes at discard for various crane types

Crane	• •	Safety factor at discard ards.iteh.ai)	Residual lifetime at discard %
Mobile cranes	ISC)/PRF TS $23624^{2,5}$	60
Tower cranes	https://standards.iteh.ai/catalog	/standards/sist/ac256b60-dcad-4244	-89a9- 60
Bridge and gantry cranes	66d394b)5344/iso-prf-ts- 2,3 624	60

NOTE 1 The safety factor at discard differs from the normally used safety factor related to the beginning of the service-life.

NOTE 2 The various factors consider the risk assessment for different applications and current experience.

NOTE 3 HPFR safety factors and residual lifetimes can be reviewed after gaining future experience.

5 Crane design considerations

5.1 Termination on the drum

The termination on the drum consists of:

- a) the drum attachment; and
- b) a requisite number of safety wraps.

This termination a) and b) shall be capable of holding at least a rope force equivalent to 80 % of the safety factor at discard, *n*, multiplied by the maximum rope pull, F_{MRP} .

To calculate the required drum attachment strength, <u>Formula (1)</u> shall be used:

$$T \ge 0.8 \times n \times \frac{F_{\rm MRP}}{e^{\mu\alpha}} \tag{1}$$

where

 $F_{\rm MRP}$ is the maximum rope pull;

- *T* is the required drum attachment strength;
- *n* is the required minimum safety factor at discard (see <u>Table 1</u> and <u>Table 2</u>);
- μ is the coefficient of friction for HPFR to drum;
- α is the angle of wrap in radians, equivalent to 2π times the number of wraps on the drum.

The coefficient of friction varies with service conditions. Accordingly, testing shall be performed under the worst (slippery) service conditions (e.g. wet, oily, ice, temperature).

NOTE 1 Current experience indicates a minimum value of friction μ = 0,04.

The HPFR drum attachment a) shall be capable of holding at least 1,2-times the maximum rope pull in the rope drive. The HPFR fastening, e.g. wedge and socket, shall not become detached even when the rope pull is zero.

The termination of the HPFR shall be selected taking into account the rope and drum contours. The drum attachment a) shall be easily accessible for maintenance and replacement of the HPFR.

NOTE 2 Over time the efficiency of the termination can decrease, for example in a clamp. In such cases reapplication of a tightening force is necessary.

5.2 Termination at load side ANDARD PREVIEW

The end termination at the load side, *T* shall be capable of holding at least a rope force equivalent to 80 % of the safety factor at discard, *n*, multiplied by the maximum rope pull, F_{MRP} , as given in Formula (2).

 $T \ge 0.8 \times n \times F_{\rm MRP}$

MRP ISO/PRF TS 23624 https://standards.iteh.ai/catalog/standards/sist/ac806b60-dcad-4244-89a9-66d394b05344/iso-prf-ts-23624

where

 $F_{\rm MRP}$ is the maximum rope pull;

n is the required minimum safety factor at discard (see <u>Table 1</u> and <u>Table 2</u>).

5.3 Drum

5.3.1 Lowering limiter

The hoisting system shall be fitted with a lowering limiter. The lowering limiter shall ensure that the minimum engagement (requisite safety wraps) of the HPFR with the drum is maintained at all times during operation.

5.3.2 Forces on flange and tube (Multilayer drum)

HPFR behave differently than steel wire ropes whilst spooling on a multilayer drum and can cause significantly increased forces acting on drum flange and tube. These forces shall be taken into account where multilayer drums are equipped with HPFR. The calculation should be verified by practical testing.

NOTE A HPFR is more compressed during work than a steel wire rope, flattening the rope and causing increased lateral forces acting on the flange. The difference in axial stiffness can also increase the forces acting on the drum tube.

(2)