



BSI Standards Publication

Hydraulic fluid power — Method for evaluating the buckling load of a hydraulic cylinder

National foreword

This Published Document is the UK implementation of ISO/TS 13725:2016. It supersedes BS ISO/TS 13725:2001 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee MCE/18, Fluid power systems and components, to Panel MCE/18/-/3, Cylinders.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2016.

Published by BSI Standards Limited 2016

ISBN 978 0 580 89989 8

ICS 23.100.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 June 2016.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

TECHNICAL SPECIFICATION

ISO/TS
13725

Second edition
2016-06-01

Hydraulic fluid power — Method for evaluating the buckling load of a hydraulic cylinder

*Transmissions hydrauliques — Méthode d'évaluation du flambage
d'un vérin*



Reference number
ISO/TS 13725:2016(E)

© ISO 2016



COPYRIGHT PROTECTED DOCUMENT

© ISO 2016, Published in Switzerland

All rights reserved. Unless otherwise specified, 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
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Symbols and units	1
2.1 General.....	1
2.2 Additional notations.....	2
3 General principles	3
3.1 Purpose.....	3
3.2 Description.....	3
3.3 Dimensional layout of hydraulic cylinder.....	3
3.4 Common calculation of maximum stress in the rod (for all mounting types) σ_{\max}	5
3.4.1 Deflexion curve.....	6
3.4.2 Bending moment.....	6
3.4.3 Maximum value of the bending moment.....	6
3.4.4 Maximum stress of the piston rod.....	7
3.4.5 Mounting types of the cylinder tube and piston rod.....	7
4 Case of pin-mounted hydraulic cylinders	8
4.1 Model of the hydraulic cylinder and unknown values.....	8
4.2 Linear system.....	9
4.3 Critical buckling load.....	9
4.4 Greatest allowable compressive load.....	10
5 Case of hydraulic cylinders fixed at the beginning of the cylinder tube and pin mounted at the end of the piston rod	10
5.1 Critical buckling load.....	10
5.2 Linear system.....	10
6 Case of hydraulic cylinders pin mounted at the beginning of the cylinder tube and fixed at the end of the piston rod	11
6.1 Critical buckling load.....	11
6.2 Linear system.....	11
7 Case of hydraulic cylinders fixed at both ends	12
7.1 Critical buckling load.....	12
7.2 Linear system.....	12
8 Case of hydraulic cylinders fixed at the beginning of the cylinder tube and free at the end of the piston rod	13
8.1 Critical buckling load.....	13
8.2 Linear system.....	14
9 Case of hydraulic cylinders fixed at both ends with free movement allowed at the end of the piston rod	15
9.1 Critical buckling load.....	15
9.2 Linear system.....	15
Annex A (informative) Example of numerical results	17
Bibliography	19

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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 131, *Fluid power systems*, Subcommittee SC 3, *Cylinders*.

This second edition cancels and replaces the first edition (ISO/TS 13725:2001), which has been technically revised.

Introduction

Historically, cylinder manufacturers in the fluid power industry have experienced very few rod buckling failures, most likely due to the use of adequately conservative design factors employed during cylinder design and to the recommendation of factors of safety to the users. Many countries and some large companies have developed their own methods for evaluating buckling load.

The method presented in this Technical Specification has been developed to comply with the requirements formulated by ISO/TC 131.

Hydraulic fluid power — Method for evaluating the buckling load of a hydraulic cylinder

1 Scope

This document specifies a method for the evaluation of the buckling load which

- takes into account a geometric model of the hydraulic cylinder, meaning it does not treat the hydraulic cylinder as an equivalent column,
- can be used for all types of cylinder mounting and rod end connection specified in [Table 2](#),
- includes a factor of safety, k , to be set by the person performing the calculations and reported with the results of the calculations,
- takes into account possible off-axis loading,
- takes into account the weight of the hydraulic cylinder, meaning it does not neglect all transverse loads applied on the hydraulic cylinder,
- can be implemented as a simple computer program, and
- considers the cylinder fully extended.

The method specified is based on the elastic buckling theory and is applicable to single and double acting cylinders that conform to ISO 6020 (all parts), ISO 6022 and ISO 10762. If necessary, finite element analyses can be used to verify as well as to determine the buckling load.

The method is not developed for thin-walled cylinders, double-rods or plunger cylinders.

The method is not developed for internal (rod) buckling.

The friction of spherical bearings is not taken into account.

NOTE This method is based mainly on original work by Fred Hoblit.^[2] This method has been established in reference to the standard NF PA/T3.6.37.^[1]

2 Symbols and units

2.1 General

The symbols and units used in this document are given in [Table 1](#). See [Figures 1](#) and [2](#) for labels of dimensions and other characteristics.

Table 1 — Symbols and units

Symbol	Meaning	Unit
C	stiffness of a possible transverse support at the free end of the piston rod	N/mm
D_{1e}	outside diameter of the cylinder tube	mm
D_{1i}	inside diameter of the cylinder tube	mm
D_2	outside diameter of the piston rod	mm
e_a, e_d	distance where the loading of an eccentrically loaded column is equivalent to a concentric axial force F and end moment $M = F [x] e$	mm
E_1	modulus of elasticity of cylinder tube material	N/mm ²