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

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





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# Contents

Page

|                                                                                                                               |           |
|-------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Foreword</b>                                                                                                               | <b>iv</b> |
| <b>Introduction</b>                                                                                                           | <b>v</b>  |
| <b>1 Scope</b>                                                                                                                | <b>1</b>  |
| <b>2 Symbols and units</b>                                                                                                    | <b>1</b>  |
| 2.1 General                                                                                                                   | 1         |
| 2.2 Additional notations                                                                                                      | 2         |
| <b>3 General principles</b>                                                                                                   | <b>3</b>  |
| 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) $\sigma_{\max}$                                  | 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         |
| <b>4 Case of pin-mounted hydraulic cylinders</b>                                                                              | <b>8</b>  |
| 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        |
| <b>5 Case of hydraulic cylinders fixed at the beginning of the cylinder tube and pin mounted at the end of the piston rod</b> | <b>10</b> |
| 5.1 Critical buckling load                                                                                                    | 10        |
| 5.2 Linear system                                                                                                             | 10        |
| <b>6 Case of hydraulic cylinders pin mounted at the beginning of the cylinder tube and fixed at the end of the piston rod</b> | <b>11</b> |
| 6.1 Critical buckling load                                                                                                    | 11        |
| 6.2 Linear system                                                                                                             | 11        |
| <b>7 Case of hydraulic cylinders fixed at both ends</b>                                                                       | <b>12</b> |
| 7.1 Critical buckling load                                                                                                    | 12        |
| 7.2 Linear system                                                                                                             | 12        |
| <b>8 Case of hydraulic cylinders fixed at the beginning of the cylinder tube and free at the end of the piston rod</b>        | <b>13</b> |
| 8.1 Critical buckling load                                                                                                    | 13        |
| 8.2 Linear system                                                                                                             | 14        |
| <b>9 Case of hydraulic cylinders fixed at both ends with free movement allowed at the end of the piston rod</b>               | <b>15</b> |
| 9.1 Critical buckling load                                                                                                    | 15        |
| 9.2 Linear system                                                                                                             | 15        |
| <b>Annex A (informative) Example of numerical results</b>                                                                     | <b>17</b> |
| <b>Bibliography</b>                                                                                                           | <b>19</b> |

## 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](http://www.iso.org/directives)).

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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.<sup>[2]</sup> This method has been established in reference to the standard NF PA/T3.6.37.<sup>[1]</sup>

## 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 <sup>2</sup> |