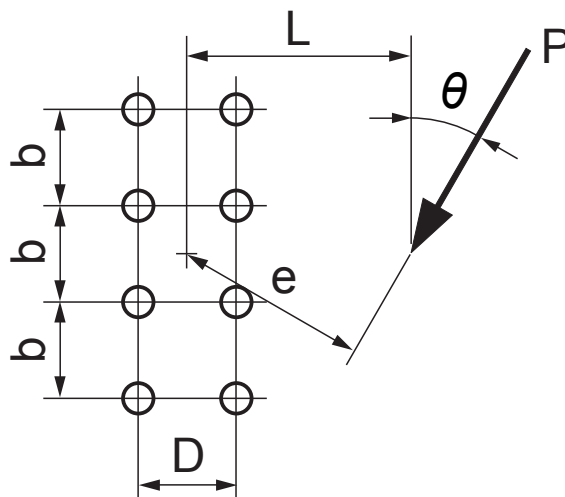


CISC Steel Design Series

Module 2 ***Bolt Groups Subjected*** ***to an Eccentric and Inclined Point Load***



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Canadian Institute of Steel Construction

CISC Steel Design Series SDS-2-R1

July 2017

Revised August 2017

ISBN 978-0-88811-213-2

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MODULE 2

BOLT GROUPS SUBJECTED TO AN ECCENTRIC AND INCLINED POINT LOAD

1. Introduction

Module Two of the *Steel Design Series (SDS-2)* aims to aid engineers in determining the resistance of bolt groups subjected to an eccentric and inclined point load. The Handbook of Steel Construction, 11th Edition, contains tables of *Eccentric Loads on Bolt Groups* for vertically applied loads. Tables 3-14 to 3-20 provide values of the coefficient, C , for bolt groups with one to four vertical rows of bolts. The bolt group resistance is given by:

$$P_f = C V_r$$

where V_r is the factored shear resistance of a single bolt according to CSA S16-14 Clause 13.12.1.2(c).

The charts below are intended to supplement the Handbook tables and provide values of C for one and two vertical rows of bolts and for load directions within 90° of the vertical. Resistances are given for values of the distance, L , defined as the horizontal distance between the bolt group centroid and the point of intersection of the horizontal line through the centroid and the line of application of the inclined load (See Figures).

Values of L range from 50 to 700 mm (depending on the bolt configuration), and are related to the eccentricity, e , according to the equation:

$$e = L \cos \theta$$

where θ is the angle between the load direction and the vertical.

Resistances have been calculated using the instantaneous centre of rotation method (Crawford and Kulak, 1971) for bearing-type joints with A325 bolts. Although the coefficients C may vary slightly for connections involving A490 bolts, it has become the practice to provide only one set of values for bolt groups consisting of A325 or A490 bolts (Kulak *et al.*, 1987). The values of C provided herein correspond to the ultimate strength of bearing-type bolted joints, although they may be conservatively used for slip-critical joints:

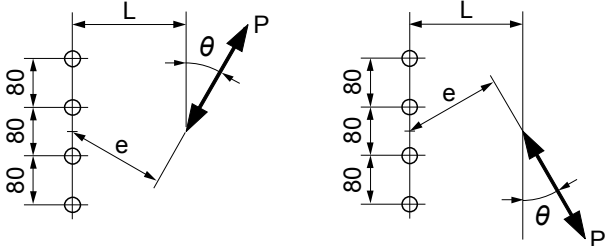
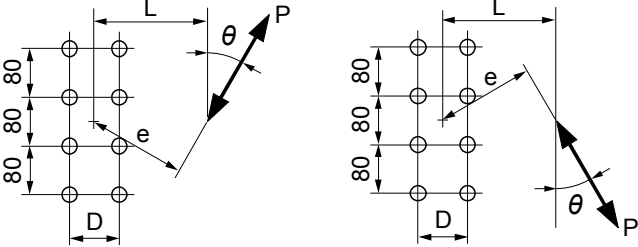
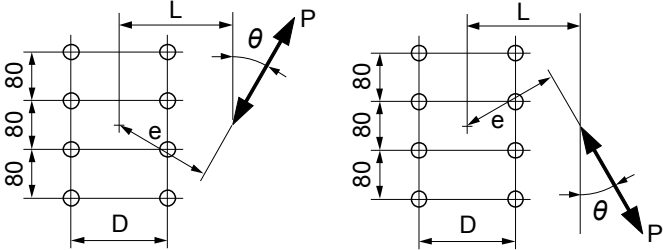
$$P = C V_s$$

where V_s is the slip resistance of a single bolt according to Clause 13.12.2.2.

Other aspects of the design of bolted joints, such as the resistance of the bolted parts, are beyond the scope of *SDS-2*. Charts have been chosen over tables because the curves are concave up. Since tables can only cover a finite set of discrete angles, linear interpolation of C -values for angles other than those tabulated always errs on the unconservative side and, in some cases, interpolated values are grossly unconservative.

2. Figures

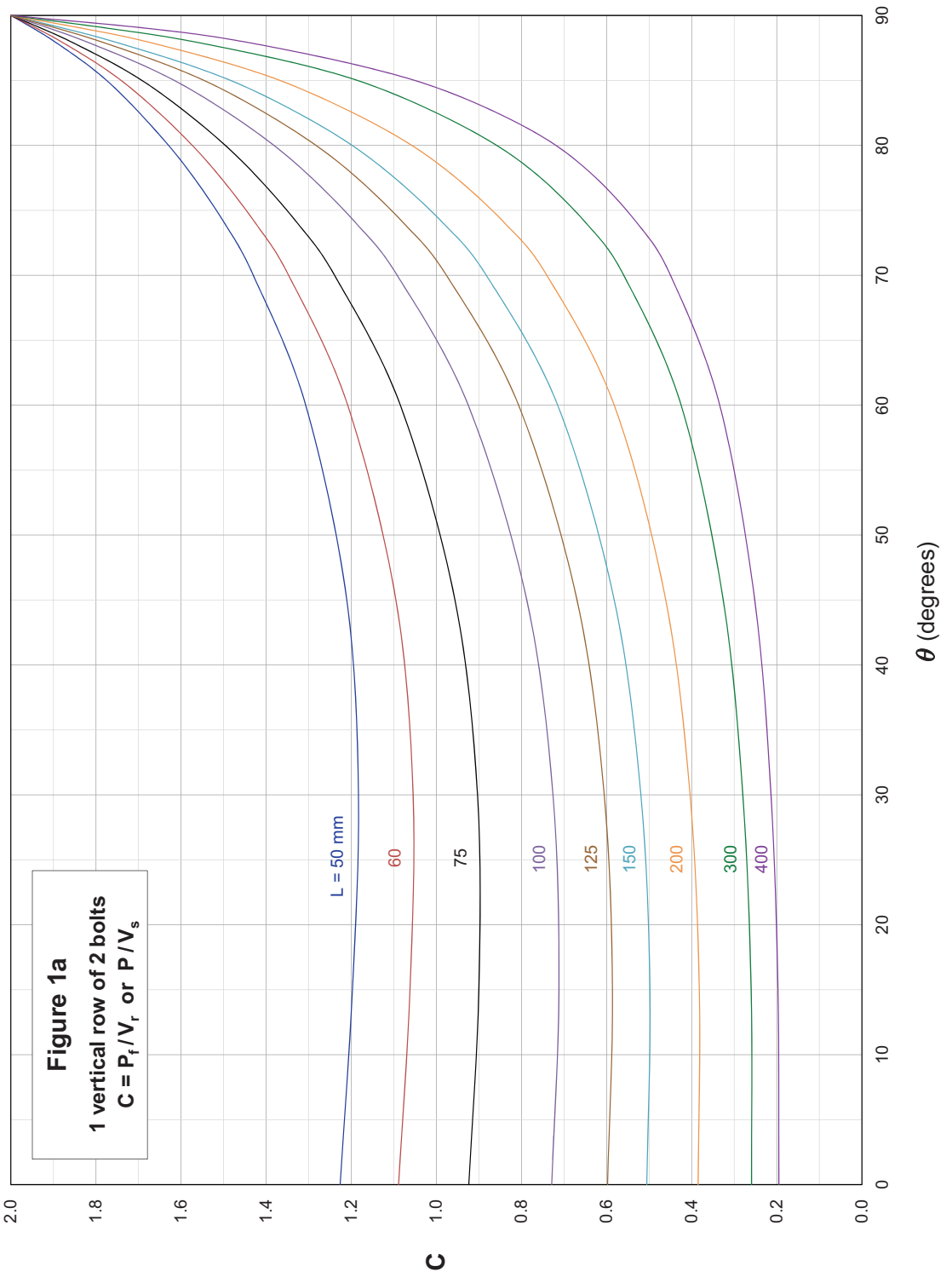
Three sets of charts are provided on the following pages. For all bolt configurations, the bolt pitch, $b = 80$ mm.

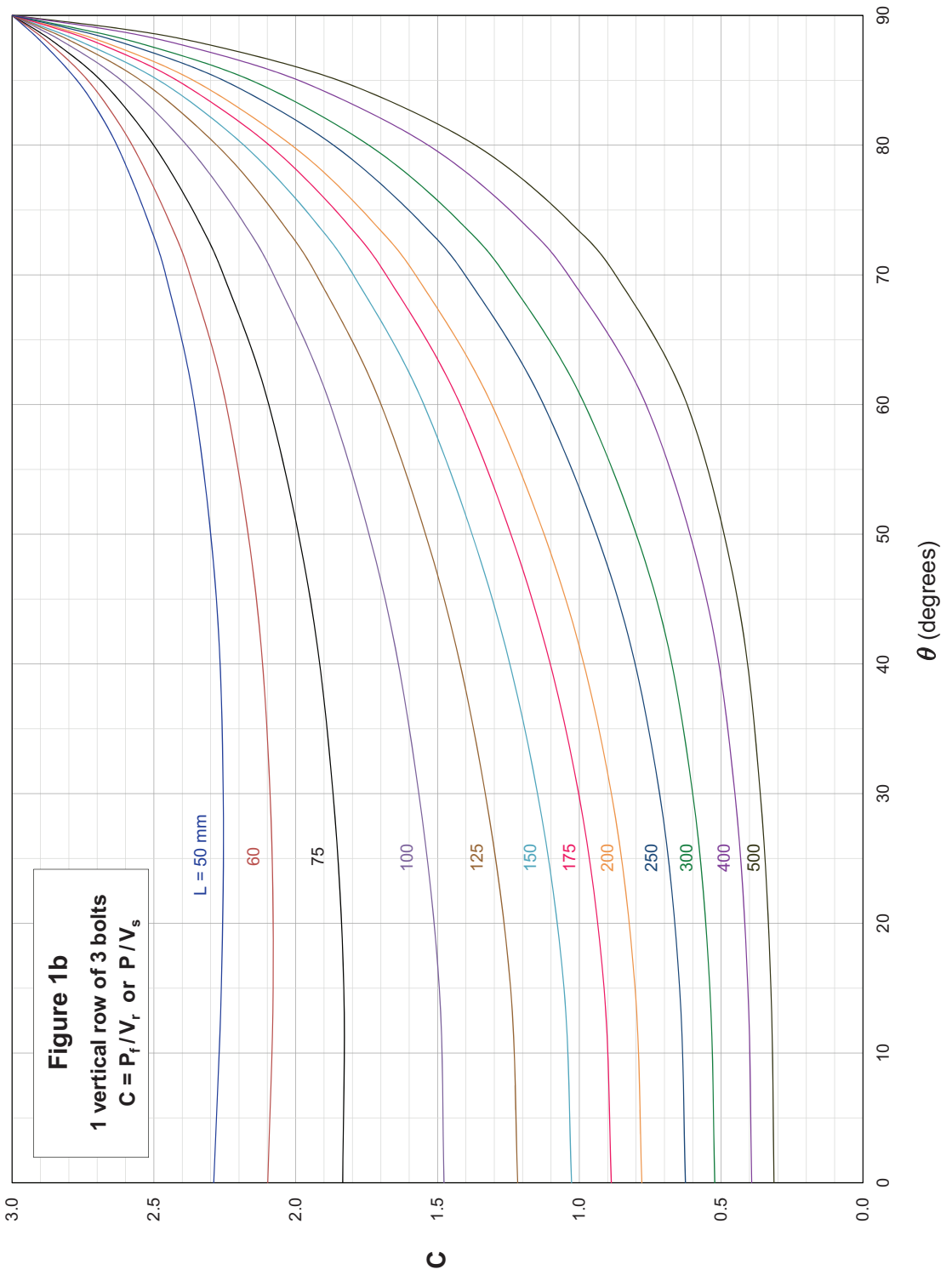
Figures	Bolt Configuration
<p>Figures 1a to 1f Single vertical row of 2 to 7 bolts</p>	
<p>Figures 2a to 2e Two vertical rows of 2 to 6 bolts Gauge, $D = 80$ mm</p>	
<p>Figures 3a to 3e Two vertical rows of 2 to 6 bolts Gauge, $D = 160$ mm</p>	

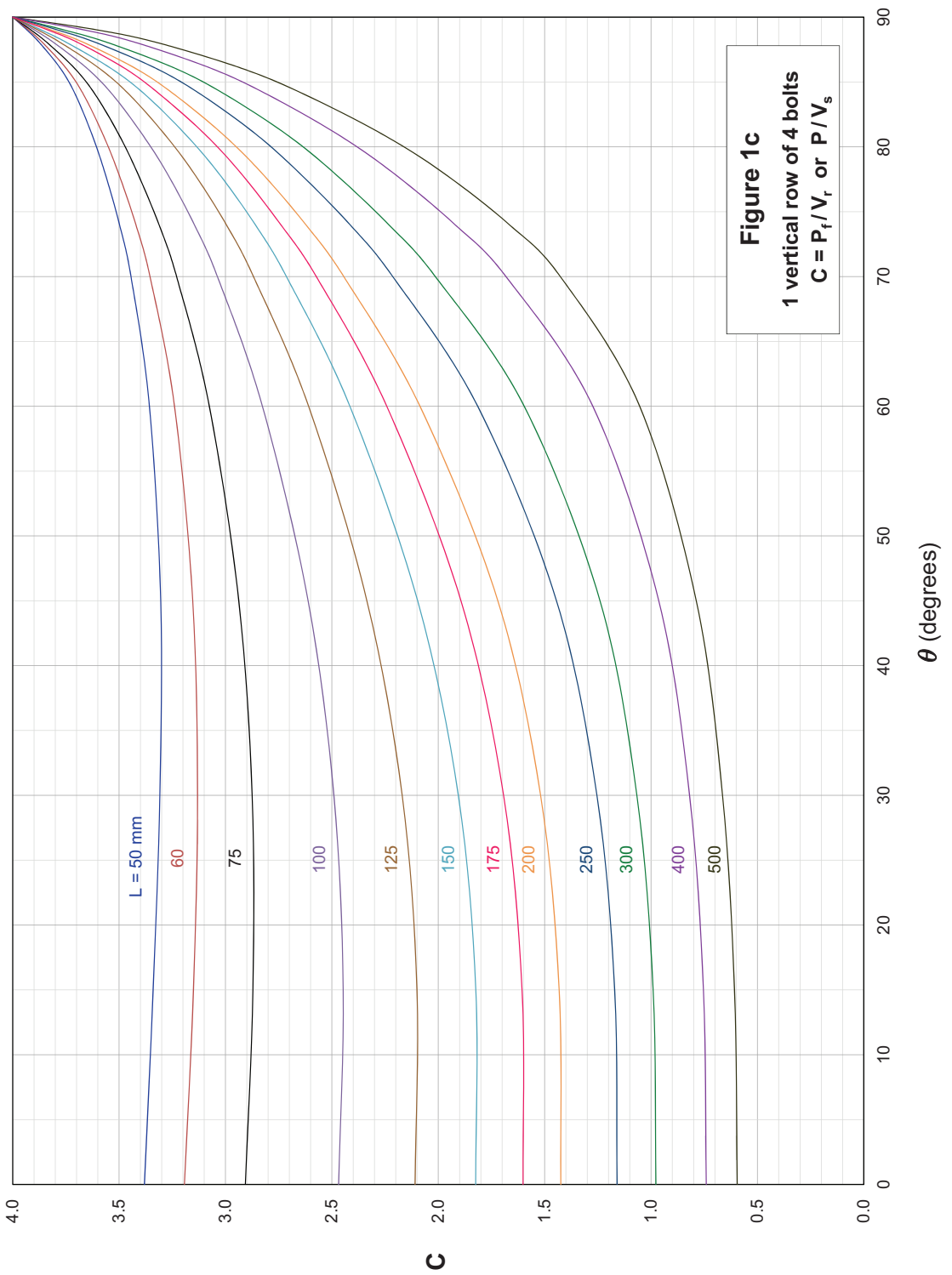
3. References

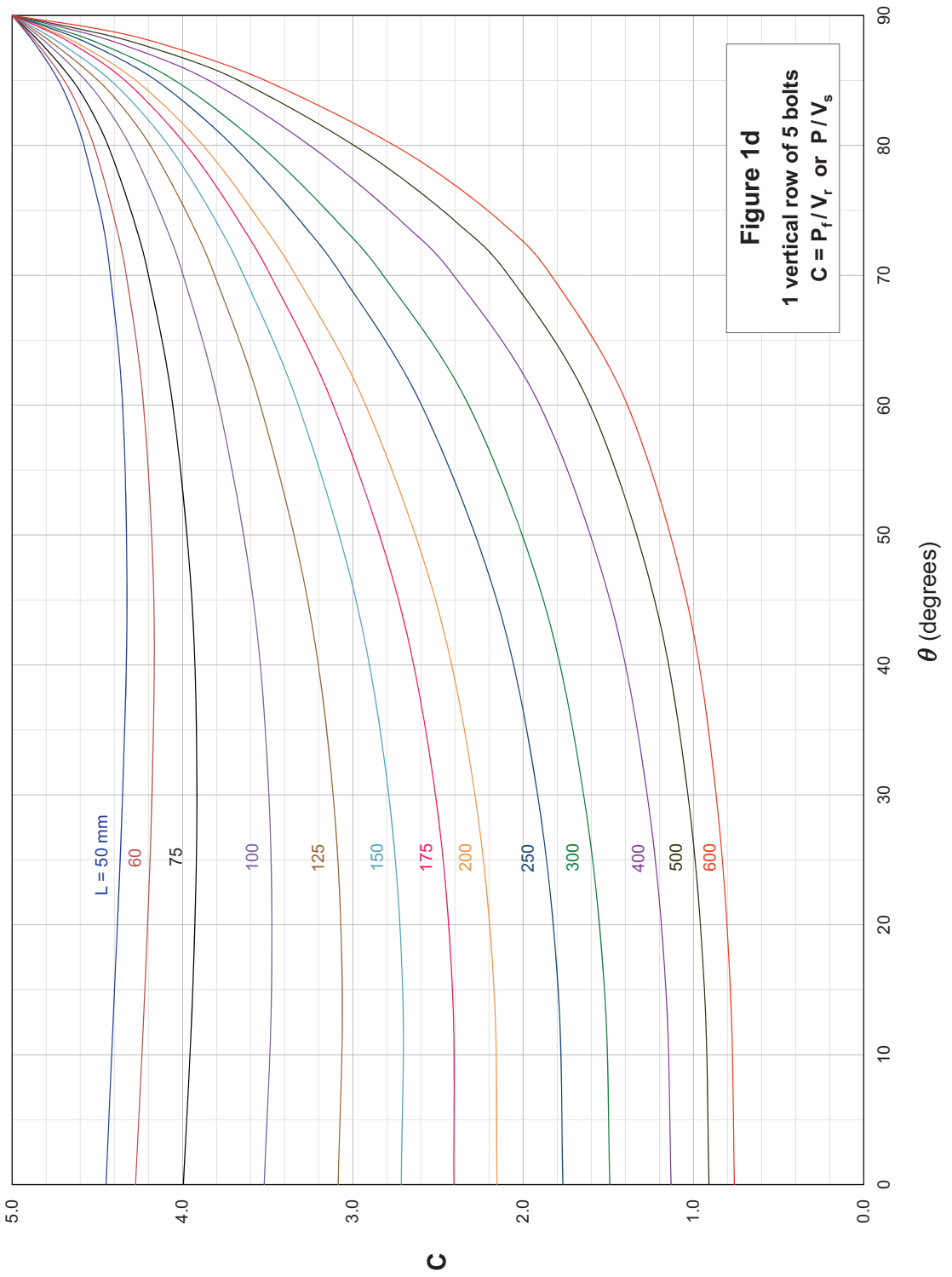
Crawford, S.F., and Kulak, G.L. 1971. Eccentrically loaded bolted connections. ASCE Journal of the Structural Division, 97(ST3), March.

Kulak, G.L., Fisher, J.W., and Struik, J.H.A. 1987. Guide to design criteria for bolted and riveted joints, 2nd Edition. John Wiley and Sons.









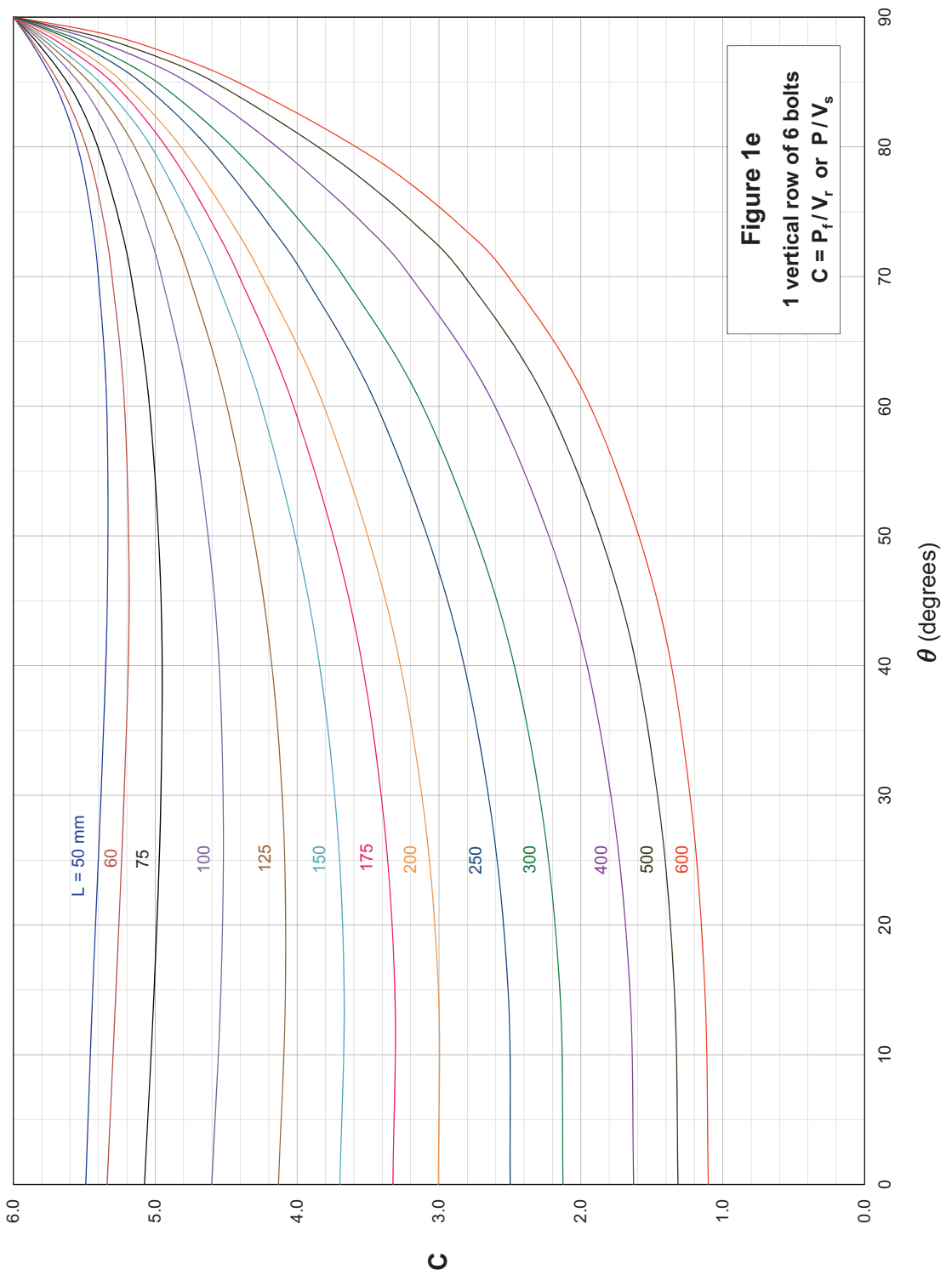


Figure 1e
 1 vertical row of 6 bolts
 $C = P_f/V_r$ or P/V_s

