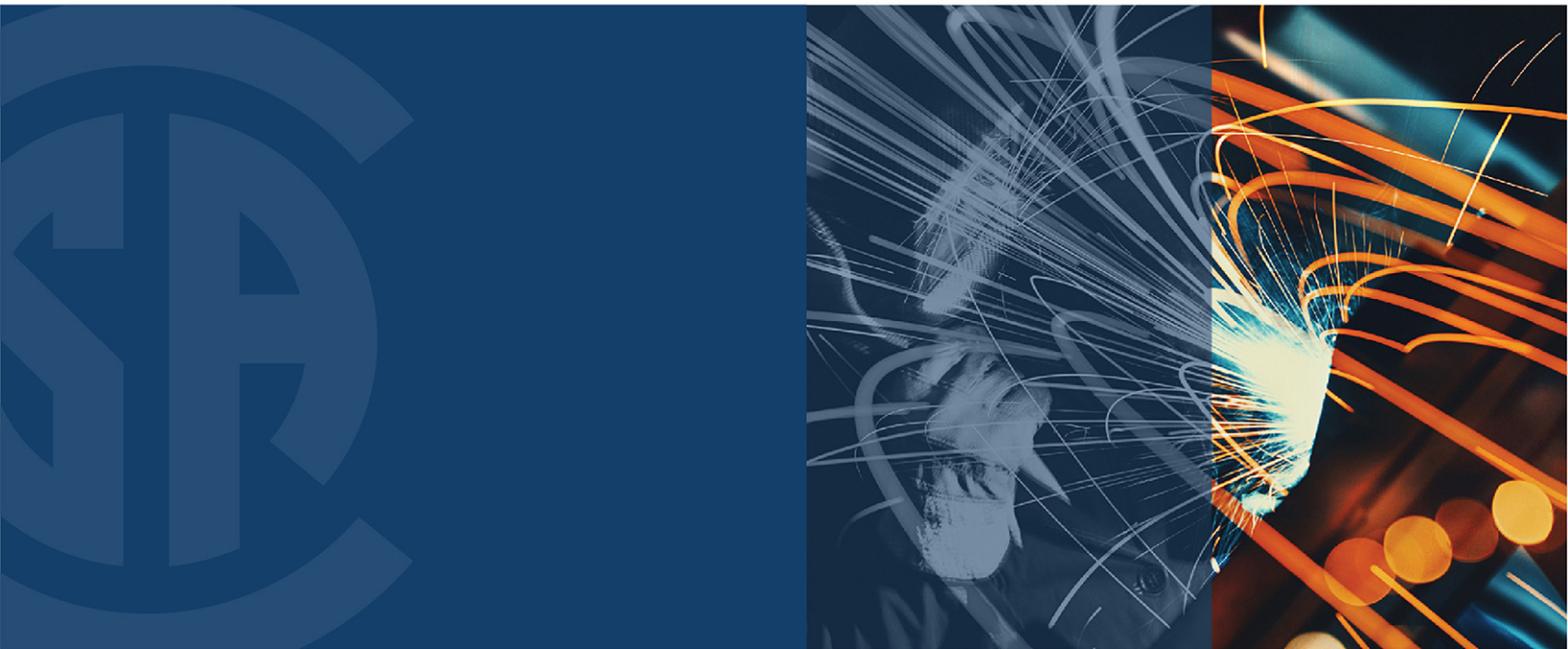




CSA G401:24
National Standard of Canada



Corrugated steel pipe and buried structures



Legal Notice for Standards

Canadian Standards Association (operating as “CSA Group”) develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document’s fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party’s intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document’s compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group’s and/or others’ intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.



Standards Update Service

CSA G401:24 *February 2024*

Title: *Corrugated steel pipe and buried structures*

To register for e-mail notification about any updates to this publication

- go to www.csagroup.org/store/
- click on **CSA Update Service**

The **List ID** that you will need to register for updates to this publication is **2431188**.

If you require assistance, please e-mail techsupport@csagroup.org or call 416-747-2233.

Visit CSA Group's policy on privacy at www.csagroup.org/legal to find out how we protect your personal information.

Canadian Standards Association (operating as “CSA Group”), under whose auspices this National Standard has been produced, was chartered in 1919 and accredited by the Standards Council of Canada to the National Standards system in 1973. It is a not-for-profit, nonstatutory, voluntary membership association engaged in standards development and certification activities.

CSA Group standards reflect a national consensus of producers and users — including manufacturers, consumers, retailers, unions and professional organizations, and governmental agencies. The standards are used widely by industry and commerce and often adopted by municipal, provincial, and federal governments in their regulations, particularly in the fields of health, safety, building and construction, and the environment.

More than 10 000 members indicate their support for CSA Group’s standards development by volunteering their time and skills to Committee work.

CSA Group offers certification and testing services in support of and as an extension to its standards development activities. To ensure the integrity of its certification process, CSA Group regularly and continually audits and inspects products that bear the CSA Group Mark.

In addition to its head office and laboratory complex in Toronto, CSA Group has regional branch offices in major centres across Canada and inspection and testing agencies in fourteen countries. Since 1919, CSA Group has developed the necessary expertise to meet its corporate mission: CSA Group is an independent service organization whose mission is to provide an open and effective forum for activities facilitating the exchange of goods and services through the use of standards, certification and related services to meet national and international needs.

For further information on CSA Group services, write to
CSA Group
178 Rexdale Boulevard
Toronto, Ontario, M9W 1R3
Canada

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited Standards Development Organization, in compliance with requirements and guidance set out by SCC. More information on National Standards of Canada can be found at www.scc.ca.

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada’s economic competitiveness and social wellbeing, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at www.scc.ca.

Standards Council of Canada
600-55 Metcalfe Street
Ottawa, Ontario, K1P 6L5
Canada



Cette Norme Nationale du Canada n’est disponible qu’en anglais.

Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users to judge its suitability for their particular purpose.

®A trademark of the Canadian Standards Association, operating as “CSA Group”

National Standard of Canada

CSA G401:24

***Corrugated steel pipe and buried
structures***



*®A trademark of the Canadian Standards Association,
operating as "CSA Group"*



*Published in February 2024 by CSA Group
A not-for-profit private sector organization
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3*

*To purchase standards and related publications, visit our Online Store at
www.csagroup.org/store/ or call toll-free 1-800-463-6727 or 416-747-4044.*

*ICS 23.040.10
ISBN 978-1-4883-5076-4*

*© 2024 Canadian Standards Association
All rights reserved. No part of this publication may be reproduced in any form whatsoever
without the prior permission of the publisher.*

Contents

Technical Committee on Corrugated Steel Pipe and Buried Structures	3
Preface	6
SDG Foreword	8
1 Scope	9
2 Reference publications	9
3 Definitions and abbreviations	14
3.1 Definitions	14
3.2 Abbreviations and symbols	17
4 Corrugated and spiral rib steel pipe — Material and fabrication	17
4.1 Steel material	17
4.1.1 General	17
4.1.2 Heat analysis	18
4.1.3 Product analysis	18
4.1.4 Referee analysis	18
4.2 CSP and spiral rib materials	18
4.3 Tolerances	19
4.4 Mill marking	19
4.5 Fasteners	19
4.5.1 Bolts and nuts for bolted together CSP	19
4.5.2 Bolts and nuts for CSP couplers	19
4.5.3 Rivets	20
4.6 Coatings	20
4.6.1 Zinc coating for corrugated steel sheet	20
4.6.2 Aluminum coating for corrugated steel pipe sheet	20
4.6.3 Aluminized coating for corrugated steel pipe sheet	21
4.6.4 55% aluminum-zinc alloy coating for corrugated steel pipe sheet	21
4.6.5 Polymer laminate coating for corrugated steel pipe sheet	22
4.7 Fabrication of corrugated steel pipe and spiral rib steel pipe	23
4.7.1 General	23
4.7.2 Riveted corrugated steel pipe	25
4.7.3 Helical lockseam corrugated steel pipe	27
4.7.4 Pipe-arch	31
4.7.5 Perforated corrugated steel pipe	32
4.7.6 Bolted corrugated steel pipe	33
4.7.7 Couplers	35
4.7.8 Fittings and appurtenances	36
5 Structural plate and deep corrugated structural plate — Material and fabrication	37
5.1 Steel material	37
5.1.1 General	37
5.1.2 Heat analysis	37

5.1.3	Product analysis	37
5.1.4	Referee analysis	37
5.2	Structural plate and deep corrugated structural plate materials	37
5.3	Tolerances	38
5.4	Mill marking	38
5.5	Bolts and nuts for structural plate	38
5.6	Coatings	39
5.6.1	Zinc coating for structural plate and deep corrugated structural plate	39
5.6.2	Thermoplastic copolymer coating for structural plate and deep corrugated structural plate	40
5.6.3	Alternative coating for structural plate and deep corrugated structural plate	41
5.7	Fabrication of structural plate and deep corrugated structural plate steel pipe	41
5.7.1	General	41
5.7.2	Corrugation profile	41
5.7.3	Structural plate dimensions	42
5.7.4	Plate curvature	45
5.7.5	Receiving members	45
5.7.6	Bolts and nuts	46
5.7.7	Drawings and plate identification	46
6	Quality of work and repair	47
6.1	Quality of work	47
6.2	Repair of damaged metallic coating	47
6.3	Repair of damaged polymer and thermoplastic copolymer coatings	48
6.3.1	Damaged polymer laminate	48
6.3.2	Damaged thermoplastic copolymer	48
7	Manufacturer's quality control	48
7.1	Materials control	48
7.2	Fabrication	49
7.3	Plant quality program	49
7.3.1	Objectives and methods	49
7.3.2	Inspection, testing, and record-keeping	49
7.3.3	Assessment of plant standards	49
8	Handling, transport, storage, and repair	49
8.1	Handling	49
8.2	Transport	50
8.3	Storage	50
8.4	Repair	51
9	Inspection	51
10	Rejection	51

Annex A (informative)	— Design base steel properties	103
Annex B (informative)	— Typical coupler systems for corrugated steel pipe	106
Annex C (informative)	— Sustainability	112

Technical Committee on Corrugated Steel Pipe and Buried Structures

R. J. Wilcock	Corrugated Steel Pipe Institute (CSPI), Kitchener, Ontario, Canada <i>Category: Producer Interest</i>	<i>Chair</i>
R. Adhikari	Transportation and Economic Corridors, Government of Alberta, Edmonton, Alberta, Canada	<i>Non-voting</i>
W. J. Bartlett	NorthWest Consulting, Camlachie, Ontario, Canada <i>Category: Engineering Consultant</i>	
I. Berry	Warner Custom Coating, Guelph, Ontario, Canada <i>Category: General Interest</i>	
M. Cayanan	The City of Calgary, Calgary, Alberta, Canada <i>Category: User Interest</i>	
J. Clarke	Nova Scotia Department of Pubic Works, Halifax, Nova Scotia, Canada	<i>Non-voting</i>
J. Combe	Ontario Ministry of Transportation, St. Catharines, Ontario, Canada <i>Category: User Interest</i>	
K. Derayah	ArcelorMittal Dofasco, Hamilton, Ontario, Canada <i>Category: Producer Interest</i>	
T. Dunn	Atlantic Industries Limited, St. John's, Newfoundland and Labrador, Canada <i>Category: Producer Interest</i>	
M. M. El-Sharnouby	Atlantic Industries Limited, Cambridge, Ontario, Canada	<i>Non-voting</i>

A. Granville	Department of Transportation and Infrastructure – Government of Newfoundland & Labrador, St. John's, Newfoundland and Labrador, Canada <i>Category: User Interest</i>	
A. Hegedus	Saskatchewan Ministry of Highways, Regina, Saskatchewan, Canada	<i>Non-voting</i>
N. Lawless	PEI Transportation and Infrastructure, Charlottetown, Prince Edward Island, Canada	<i>Non-voting</i>
C. Leishman	ISL Engineering and Land Services Ltd., Lethbridge, Alberta, Canada <i>Category: Engineering Consultant</i>	
S. MacRae	Armtec Inc, Cambridge, Ontario, Canada <i>Category: Producer Interest</i>	
B. W. Matheson	Frontier Construction Products Ltd., Thorsby, Alberta, Canada <i>Category: Producer Interest</i>	
B. Phillips	Corbec, Hamilton, Ontario, Canada <i>Category: General Interest</i>	
D. Ross	Saskatchewan Ministry of Highways, Saskatoon, Saskatchewan, Canada <i>Category: User Interest</i>	
A. Soto	TC Energy, Calgary, Alberta, Canada	<i>Non-voting</i>
L. Stepan-Stancioi	Ministère des Transports, Québec, Québec, Canada <i>Category: User Interest</i>	
B. Stirling	Klohn Crippen Berger, Vancouver, British Columbia, Canada <i>Category: Engineering Consultant</i>	

L. Xu University of Waterloo,
Waterloo, Ontario, Canada
Category: General Interest

K. Phu CSA Group, *Project Manager*
Toronto, Ontario, Canada

Preface

This is the sixth edition of CSA G401, *Corrugated steel pipe and buried structures*. It supersedes the previous editions published in 2014, 2007, 2001, 1993, and 1981 under the title *Corrugated steel pipe products*.

Changes have been made to this Standard to permit materials, manufacturing methods, and inspection procedures that meet appropriate, current, and projected industry practices. These changes include the following:

- a) changed standard name to *Corrugated steel pipe and buried structures*;
- b) removed spiral rib pipe Type II;
- c) added profile structural plate Type III;
- d) expanded tunnel liner plate to Types I and II;
- e) added zinc flake coated bolts and nuts;
- f) added alternative coating for structural plate and deep corrugated structural plate;
- g) added clause for helical welded lockseam;
- h) added requirements in Clause 6, Quality of work and repair;
- i) rewrote Clause 8, Handling, transport, storage and repair;
- j) removed Tables 10 and 11 for minimum outside circumference;
- k) updated bolt tables to imperial dimensions only, as metric is not available; and
- l) added Annex C (informative), Sustainability.

This Standard is considered suitable for use for conformity assessment within the stated scope of the Standard.

CSA Group acknowledges that the development of this Standard was made possible, in part, by the financial support of the Corrugated Steel Pipe Institute (CSPI). Such support does not indicate endorsement of the contents of this Standard.

This Standard was prepared by the Technical Committee on Corrugated Steel Pipe and Buried Structures, under the jurisdiction of the Strategic Steering Committee on Construction and Civil Infrastructure, and has been formally approved by the Technical Committee.

This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Notes:

- 1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- 2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
- 3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as “substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity”. It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
- 4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include “Request for interpretation” in the subject line:*
 - a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
 - b) *provide an explanation of circumstances surrounding the actual field condition; and*