

Journal of ASTM International
Selected Technical Papers



STP 1528

Plastic Pipe and Fittings

Past, Present, and Future

JAI Guest Editor

Thomas S. Walsh

**Journal of ASTM International
Selected Technical Papers STP1528
Plastic Pipe and Fittings: Past, Present,
and Future**

JAI Guest Editor:
Thomas S. Walsh



ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959

Printed in the U.S.A.

ASTM Stock #: STP1528

Library of Congress Cataloging-in-Publication Data

ISSN: 978-0-8031-7514-3

Copyright © 2011 ASTM INTERNATIONAL, West Conshohocken, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Journal of ASTM International (JAI) Scope

The JAI is a multi-disciplinary forum to serve the international scientific and engineering community through the timely publication of the results of original research and critical review articles in the physical and life sciences and engineering technologies. These peer-reviewed papers cover diverse topics relevant to the science and research that establish the foundation for standards development within ASTM International.

Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use, or the internal, personal, or educational classroom use of specific clients, is granted by ASTM International provided that the appropriate fee is paid to ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9634; online: <http://www.astm.org/copyright>.

The Society is not responsible, as a body, for the statements and opinions expressed in this publication. ASTM International does not endorse any products represented in this publication.

Peer Review Policy

Each paper published in this volume was evaluated by two peer reviewers and at least one editor. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM International Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of the peer reviewers. In keeping with long-standing publication practices, ASTM International maintains the anonymity of the peer reviewers. The ASTM International Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM International.

Citation of Papers

When citing papers from this publication, the appropriate citation includes the paper authors, "paper title", J. ASTM Intl., volume and number, Paper doi, ASTM International, West Conshohocken, PA, Paper, year listed in the footnote of the paper. A citation is provided as a footnote on page one of each paper.

Foreword

THIS COMPILATION OF THE *JOURNAL OF ASTM INTERNATIONAL (JAI)*, STP1528, *Plastic Pipe and Fittings: Past, Present, and Future* contains only the papers published in JAI that were presented at a Symposium on Plastic Pipe and Fittings: Yesterday, Today, and Tomorrow held during November 9, 2009 in Atlanta, GA, USA. The Symposium was sponsored by ASTM International Committee F17 on Plastic Piping Systems.

Thomas S. Walsh, Walsh Consulting Services, Houston, TX served as the Symposium Chairman and JAI Guest Editor.

Contents

Overview.	vii
-------------------	-----

Historical Reviews

North America's Cinderella Pipe Story: A Look at PVC Pipes' Climb to the Top B. Walker.	3
A Brief History of the Introduction, Development and Growth of the Corrugated Polyethylene Pipe Industry in North America J. B. Goddard.	20
The Hydrostatic Stress Board of Plastics Pipe Institute: The First 50 Years S. A. Mruk	35
Long-Term Hydrostatic Strength and Design of Thermoplastic Piping Compounds S. Boros.	56
NSF 14: Shaping the Future of the Plastic Piping Industry A. Ciechanowski.	73
ASTM D 3350: A Historical and Current Perspective on a Standard Specification for Identification of Polyethylene Plastics Pipe and Fittings Materials W. G. Jee.	82

Design

A Service Life Assessment of Corrugated HDPE Drainage Pipe M. Pluimer.	91
Designing Stormwater Chambers to Meet AASHTO Specifications T. J. McGrath and D. Mailhot.	102
Design and Performance of Plastic Drainage Pipes in Environmental Containment Facilities R. W. I. Brachman.	113
Design Development of Large Thermoplastic Chambers for StormWater Retention B. J. Bass, T. J. McGrath, D. Mailhot, and K.-W. Lim	132
Technical Considerations When Fabricating PVC Pressure Fittings T. Franzen, C. Fisher, and S. Rahman	150
Deflection Lag, Load Lag, and Time Lag of Buried Flexible Pipe A. Howard.	162

Testing and Failure Analysis

Stress Crack Protocol for Finished Product Testing of Corrugated High Density Polyethylene Pipe J. M. Kurdziel.	173
Guided Side-Bend: An Alternative Qualification Method for Butt Fusion Joining of Polyethylene Pipe and Fittings S. Sandstrum, D. Burwell, S. McGriff, J. Craig, and H. Svetlik.	190

Tensile Testing of a Push-On Restrained Joint PVC Pipe	
C. Fisher and G. Quesada	216
Building Knowledge from Failure Analysis of Plastic Pipe and Other Hydraulic Structures	
P. A. Sharff, S. C. Bellemare, and L. M. Witmer	229
Challenges in Investigating Chlorinated Polyvinyl Chloride Pipe Failures	
M. D. Hayes, M. L. Hanks, F. E. Hagan, D. Edwards, and D. Duvall	252
Environmental Stress Cracking of Commercial CPVC Pipes	
R. I. Hauser.	269
How to Crawl Through a Pipe—Terminology	
A. Howard	279

New Materials and Applications

Yesterday, Today, and Now: Polyamide-11 Gas Piping at 200 psig Under the New Rules	
F. Volgstadt	289
Polyamide 12 Natural Gas Distribution Systems Operating at Pressure Greater Than 125 Psig	
R. Wolf	309
Plastic Tubing Prospect to Replace Cast Iron Conduit in Steam Heating Systems	
I. Zhadanovsky	320

Installation

Specifying Plastics Pipes for Trenchless Applications	
L. J. Petroff	331
Trenchless Case History—University of Denver’s Use of High-Performance Restrained-Joint Water Distribution Pipe	
S. B. Gross and B. Tippetts	352
Unique Calibration Case Study for Predictive Model of Installation Loads for Directional Drilled Fusible PVC Pipe	
R. (Bo) Botteicher and S. T. Ariaratnam	360
Axial Response of HDPE Pipes as a result of Installation by Directional Drilling	
I. D. Moore, R. W. I. Brachman, J. A. Cholewa, and A. G. Chehab.	380
Author Index	395
Subject Index	397

Overview

This symposium is a continuation of two previous ASTM symposia, “Buried Plastic Pipe Technology,” (STP1093) held in 1990 and “Buried Plastic Pipe Technology, 2nd Volume,” (STP1222) held in 1994. The first symposium on Buried Plastic Technology was organized to provide the users of water, sewer, drainage waste management, irrigation and gas projects with the current state of the art engineering data and techniques for the use of plastic piping materials. The second symposia followed as a sequel to the first repeating the same intent. The current symposia has similar intentions but also was organized to capture historical viewpoints on the last sixty plus years of the successful introduction and use of plastic piping products in North America. The papers are organized into five sections: Historical Reviews, Design, Testing and Failure Analysis, New Materials and Applications, and Installation.

In the Historical Review section, Bob Walker presented an overview of the successful introduction and growth of the PVC piping industry in North American markets. Jim Goddard discussed the growth of the polyethylene corrugated pipe industry in North America. Stan Mruk reviewed the history of the Hydrostatic Stress Board (HSB) of the Plastics Pipe Institute (PPI) and its contributions to the development of plastic pressure piping products. Steve Boros discussed the use of long-term hydrostatic strength calculations in the design and development of thermoplastic piping materials and specifically polyethylene piping compounds. Ata Ciechanowski reviewed the role of the National Sanitation Foundation (NSF International) in the development of quality potable water piping products. White Jee discussed the history and the development of American Society for Testing and Materials (ASTM) Standard D3350 and its influence on polyethylene piping compounds.

In the Design section, Michael Pluimer discussed a service life analysis for corrugated high density polyethylene piping for drainage applications. Dr Tim McGrath discussed experience gained in designing storm water chambers to meet American Association of State Highway Officials (AASHTO) specifications. Dr. Richard Brachman presented information on the design and performance of plastic drainage pipes. Dr Tim McGrath reviewed the design development of large thermoplastic chambers for storm water retention systems. Craig Fisher presented considerations in the fabrication of PVC pressure fittings. Amster Howard discussed deflection, lag, lag load and time lag in drainage piping.

In the Testing and Failure Analysis section, John Kurdziel discussed a new stress cracking test method for corrugated high density polyethylene piping. Steve Sandstrum presented a new qualification test method for high density polyethylene butt fusion joining. Craig Fisher discussed the tensile

testing of restrained joint PVC pipes. Flip Sharff discussed failure analysis of plastic pipe and other hydraulic structures. Michael Hayes and Ray Hauser discussed their experiences in investigating CPVC pipe failures. Amster Howard discussed his experience in inspecting large diameter drainage piping.

In the New Materials and Applications section, Frank Volgstadt discussed Polyamide 11 (PA-11) and its use in higher pressure natural gas distribution applications. Richard Wolf discussed Polyamide 12 (PA-12) and its suitability for natural gas distribution piping systems at pressures over 125 psi. Igor Zhadanovsky discussed the use of Polysulfone plastics to replace cast iron piping in steam heating applications.

In the Installation section, Larry Petroff reviewed the specifying of plastic piping products in trenchless technology applications. Steve Gross discussed the use of high performance restrained-joint PVC piping products in directional drilling applications. Richard Botteicher presented a method for calculation installation loads on fusible PVC piping in horizontal directional drilling applications. Dr Ian Moore presented a paper on the axial response of HDPE pipes in directional drilling installations.

The goal of this symposia was to present historical perspectives from industry experts on the successful applications and growth of plastic piping and then to present papers on new materials, new applications and new test methods that are continuing the penetration of plastic piping products in North America and worldwide.

Special thanks to ASTM staff, the authors and presenters and to the reviewers of these papers without whom this STP could not have been completed.

Tom Walsh
Walsh Consulting Services
11406 Lakeside Place Drive
Houston, Texas 77077
Symposium Chairman and Editor



www.astm.org

ISBN: 978-0-8031-7514-3
Stock #: STP1528