Overview

This symposium on Buried Plastic Pipe Technology was organized to provide the many constructors of water, sewer, drainage, waste managment, irrigation, and gas projects with state of the art engineering data and techniques for the successful use of plastic piping materials.

The workshop on the day prior to the formal symposium set forth the basic properties of the various plastic piping materials-both thermoplastic and thermoset. The workshop gave the participants an introduction to the plastic pipe.

Session one deals with Testing and Standards. Ronald Bishop described a new application for ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading. This method is typically used to describe and establish pipe stiffness values for plastic pipe. Mr. Bishop extends the method over an extended time and increasing deflection to measure the retention of pipe stiffness for PVC pipe samples exposed to various environments.

Polyethylene (PE) piping has become a material of choice for many applications that benefit from this material's special ability to endure fatigue, impact loading, large deformations, abrasive materials and very agressive environments. The durability of PE's may be compromised by any one of the following causes: chemical and physical aging, weathering, creep under load, and fracture under load. Stanley Mruk in his paper reviews each of these limits and the measures taken to ensure, by modern standards, that only suitable durable materials are used for piping. Particular attention is given to the characterization and testing used to ensure that PE materials sensitive to slow crack growth are not used in piping applications.

"Widespread use of a piping product will only be achieved when there are detailed comprehensive product performance standards that can be confidently utilized by the specifying engineer." said L. E. Pearson. Mr. Pearson in his presentation, on Recent Changes in Fiberglass Pipe Specifications, describes the changes in fiberglass pipe standards issued by the American Water Works Association (AWWA) and ASTM. Among these changes have been the expansion to multible stiffness ranges, a 50 year design criteria, increased deflection to crack-damage requirements, establishment of long term ring bending strength test method, and updating and modification of test methods and performance criteria for strain corrosion and hydrostatic design basis. AWWA and ASTM product standards have been made consistent.

The German Specification ATV-127 is appropriate for static calculations of buried gravity and pressure pipelines. H. Schneider relates this specification to plastic pipe design. The specification is based on experience and allows pipe installations to be analyzed for various pipe stiffnesses, backfill and bedding conditions. Various inputs to the system such as pipe properties, soil properties and traffic loads result in a vertical deflection, a wall stress and/or strain, and a buckling calculation. Combined with minimum requirments for factors of safety, the calculated wall stress is used as a design basis for thermoplastic materials. Thermoset materials use strain as a design basis. The analysis for thermosets may be extended to a multiple layer stress or strain calculation.

D. A. Gregorka, etal., National Sanitation Foundation (NSF), Health Effects Standard and Certification of Plastics Pipe, addresses the impact NSF standards 14 and 61 on specifiers, users, and designers of plastic piping for potable water systems. Special emphasis is placed in extraction testing and toxicology requirements. NSF Standard 61, covers the health effects of indirect additives to drinking water for all types of piping materials.

In the Design part of the Symposium, the presentations centered on controlled tests on buried pipe, evaluation testing of pipe installed up to 20 years, and measurment of buried pipe deflections.

Amster Howard in Fullerton PVC Pipe Test Section describes a test section of 27-inch poly (vinyl chloride) (PVC) pipe installed in 1987. Initial measurements included pipe deflections, pipe invert elevations, soil properties, and in-place unit weights. Periodic measurments were made during the first two years to establish pipe deflection time-lag factor. The pipe was installed with three different bedding and backfill conditions.

A. P. Moser, etal., ask the question "Is PVC strain limited after all these years?". Over the years that PVC pipe has been used in buried non-pressure applications, a debate has continued over the right way to design products that are stress life dependant; but are subject to fixed strain and stress relaxation conditions over their useful life. Data from notched and unnotched pipe rings under fixed circumferential deflections of 30% to 40% is included.

Many of the presentations dealt with soil properties, installation techniques, and their effects on service performance. Kennedy, etal., describe the design of undergrund thrust restrained systems for PVC pipe. Direct shear tests were made to study the pipe-to-soil friction. The resulting data were used to formulate design parameters for PVC pipe thrust restrained systems in a wide range of soil types. Selig discussed the basic soil property requirements for basic trench and embankment requirements. He described the characteristics of compacted soils and gave representative stress-strain parameters. Greenwood and Lang introduced empirically-based modifications to the original Spangler approach to abtain a new calculation method for estimating vertical deflection of flexible pipe. These modifications are based on recent research results. Along thee lines, K. G. Leondaris describes several installations in the Middle East. These installations of GRP pipes were in areas of prevailing high temperatures, high and saline ground water tables, and corrosive soils.

Plastic pipes have long life because of their resistance to corrosion and erosion. This makes them attractive for use under long-term landfills and in aggresive environments such as sanitary landfills. R. K. Watkins report on tests at Utah State University on the performance of plastic pipes under high landfills. Plastic pipe can perform under enormous soil loads -- hundreds of feet -- if an envelope of carefully selected soil is carefully placed about the pipe. The creep of plastic materials allows the pipe to relax and so conform with the soil in a mutually supportive pipe-soil interaction.

Lars-Eric Jansen reported on the use of flexible thermoplastic pipes such as polyethylene and polypropylene for submarine outfall systems. These pipes are well suited for this use because they can be extruded in long sections, towed fully equipped with anchoring weights to the outfall site and sunk directly on to a seabed with a minimum of underwater work.

Moore and Selig describe a buckling theory for design of buried plastic pipes which combines linear shell stability theory for the structure with elastic continuum analysis for the assessment of the ground support. The theory provides stability estimates which are superior to those generated using 'spring' models for the soil, predictions of phenomena such as long-wavelength crown buckling without the need to pre-guess the deflected shape, and rational assessment of the influence of shallow cover and the quality and quantity of backfill material. Buckling as a performance limit for buried plastic pipe is discussed, and the selection of appropriate soil and polymer moduli for use in the theory is also considered.

Collins and Svetlik describe techniques to rehabilitate existing piping facilities. Collins reports on the use of centrifugally cast fiberglass pipe to renew reinforced concrete pipe by sliplining. Svetlik describes four generic processes for insert renewal of existing piping systems. These processes are linear expansion, rolldown reduction, hot swage reduction, and visco-elastic reduction.

The goal of the symposium and ASTM STP 1093 is to provide the many constructors of water, sewer, drainage, waste management, irrigation, and gas projects with state of the art engineering data and techniques for the successful use of plastic piping materials. The planning committee thinks we have done this; however, the opinions of the attendees at the symposium and the users of this volume are welcomed and solicited. Comments on needed technology and standards should be relayed to any of the planning committee members.

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