A2C06: Committee on Culverts and Hydraulic Structures
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Culverts and Drainage Structures

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As much as culverts and drainage structures have changed over the past 100 years, the next millennium should see even more rapid change and improvement. The materials, products, and construction techniques will result in more durable, better-performing structures. Design will become totally computer aided, with location and sizing based on satellite imaging and Global Positioning System (GPS) data.

MATERIALS

Materials will continue to change to provide superior durability. The idea of 20- or even 50-year design life will no longer be acceptable; 100-year design life will be a minimum requirement. Improved concrete mixes, expanded use of polymeric and epoxy coatings, and synthetic fiber reinforcement (in the concrete mixes and the polymeric materials) will lead to substantial improvements in durability and strength. Thermoplastic material properties will continue to be refined; better property control and alloying will improve product performance. Thin-walled, high-strength, flexible concrete pipe will become common.

Metal pipes will be substantially changed to improve their initial and long-term performance. New metallic and nonmetallic coatings, developed and adapted to improve durability, will allow for the use of lighter-gauge, higher-strength metals with improved economy. Nearly fully automated manufacturing equipment, developed for special profiles, will also aid tolerance controls, jointing, and installation.

Today's designs will be improved by using diameter-specific profiles. Higher-strength metals coupled with deeper profiles will further improve economy. Hydraulically smooth profiles will become the rule rather than the exception.

Improved structural economy allows the addition of new coatings to increase service life. Heavier metallic coatings and new alloys, as well as more abrasion-resistant polymer and other organic coatings, will allow service life to be extended under abrasive conditions.

INSTALLATION

Installation practice will change even more than the products. Two different changes will occur, coming from two very different directions. The use of trenchless technology (directional boring, tunneling, and jacking) will continue to expand. Open-trench installations will be done faster with more automation and better backfill control; much of it will be done automatically, without workers in the trench. Flowable fills will be widely used to allow ease of placement and improved soil-pipe interaction.

Trenches will be dug; soil, including new base material, will be instantly analyzed by computer; and after the type of backfill (including pipe strength) has been evaluated, a solution will be chosen on the basis of economics. An expert will monitor five or six

projects from a remote location and agree with or override the decision as necessary. These installations will be based on computerized plans developed by a computer-assisted design system related to GPS coordinates. Companies such as John Deere have already developed the technology, which uses computer-driven excavation equipment based on GPS placement.

Pipe joints will be gasketed and highly leak resistant. Welded joints or truly jointless pipe will be common, with some products manufactured on site. On-site manufacture or even in-the-ground pipe manufacturing will be key for the expansion and growth of trenchless installations. Manufacture of the “pipe” may involve fusing the in situ material behind the boring or tunneling equipment using heat or a binder material such as Environmental Impact.

The effect of drainage structure design on the environment will also become a controlling issue. Usable water will be the oil resource of the next millennium, requiring careful collection, use, and reuse of this precious commodity. Control of flow rates, discharge rates, and groundwater recharge will be major considerations. Stream enclosures will be designed to minimize their effect on flow, which includes the passage of fish. Surface run-off collection will be designed to control flow rates and the impact on receiving waters. Discharge of surface run-off from rain or snow into nonusable receiving waters (salt water, polluted water) will be unacceptable, both environmentally and fiscally. Where in situ soils are permeable enough, recharge of groundwater with collected surface flows will become standard. These designs will require larger pipe sizes and more sophisticated approaches. Simply designing runs of pipe adjacent to transportation facilities will not be sufficient to accomplish these objectives. The pipe system will be used to help treat run-off and eliminate pollution.

FUTURE OUTLOOK

Although this millennium is ending with the most intense competitive battle among manufacturers of different pipe materials ever seen in the marketplace, the future will belong to the industry and products that can best respond to the new demands both in terms of performance and installation. As a result, pipe users will enjoy the competitive atmosphere and greatly benefit from improved and safer installation practices.