What is the Practical Accuracy of Crack Measurement in Concrete Pipes?[1]

American Concrete Pipe Association
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An educational document from the American Concrete Pipe Association for users and specifiers

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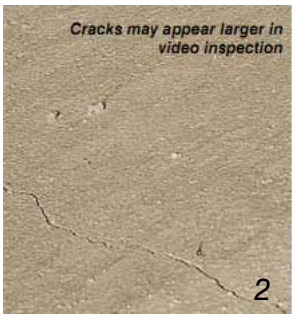
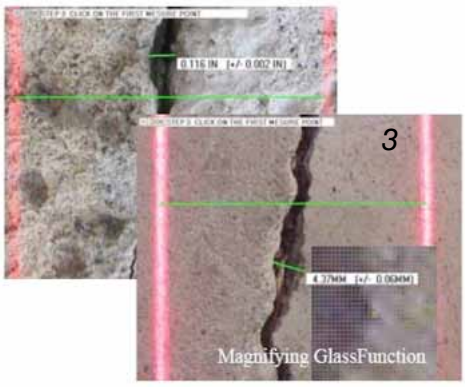


The next time you receive change after buying a cup of coffee, hold up a dime and study its thickness. Then, imagine dividing the thickness of the dime into fifths. One fifth of the thickness of a U.S. dime is the approximate width of a 0.01 inch crack. (According to the United States Mint, a dime is 1.35 mm thick). When cracks occur in new reinforced concrete pipe (RCP) installations, they are typically equal to or less than 0.01 inch wide.

In May 2006, the Florida Department of Transportation (FDOT) began requiring the measurement of cracks, joint gaps and defects in all pipe types (RCP, PVC, HDPE and metal) for 48-inch diameter and smaller pipe. Many municipalities have since followed suit as well as other DOTs across the country. FDOT also requires the measurement of pipe shape deformation using laser profiling technology. While laser profiling is currently required for all pipe in Florida, there is widespread support in the construction and inspection communities that deformation measurements are irrelevant in RCP, a rigid pipe that does not appreciably deflect.

While still imagining one fifth of a U.S. dime's thickness, consider whether a pipe inspector can reasonably be expected to place a laser image typically wider than the crack being measured, precisely on each edge of a 0.01 inch wide crack. Unfortunately, this is exactly what storm pipe inspectors are expected to do in Florida and elsewhere.

Pipe industry professionals have observed the use of precision measurement technology without a full appreciation of the limitations of the equipment and the human factors involved. This results in inaccurate crack measurements. In general, pipe utility contractors have come to accept and support final inspection results. However, inconsistency and unreliability of field measurements erodes confidence in the inspection process. This, in turn, threatens the future of final inspection and crack measurement as a useful tool in approximating crack widths when assessing pipe conditions. For this reason, the pipe inspection and construction engineering communities must fully understand the practical accuracy of using precision crack measurement technology.



There are only a few primary inspection systems used by storm pipe inspection contractors in Florida. Since 2006, hundreds of pipe inspection videos and reports have been reviewed, including thousands of crack measurements and joint gap measurements. Approximately 75% of the crack width measurements reviewed were not accurately reported, regardless of the type or brand of equipment. Some crack widths have been under-estimated, while most have been over-estimated. Unfortunately the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) certification training had no bearing on whether an inspector reported crack width measurements accurately using the inspection devices.

Generally, equipment manufacturers' specifications and accuracy test reports are readily available. Based upon manufacturer literature, it appears that the market-available crack measurement equipment and conventional camera systems are accurate to as low as 0.03 inch in a controlled environment (lab). However, manufacturer accuracy demonstrations based upon the use of digital camera equipment and flat concrete slabs will differ from the accuracy when using more typical analog camera systems and measuring inside a curved surface such as a pipe.

Overall crack measurement accuracy depends on (a) technology (analog/digital) accuracy and (b) operator skill and repeatability. For instance, laser diodes must be precisely perpendicular (90 degrees) or else accuracy is greatly compromised. Despite some cameras' capabilities of 90 degree automatic rotation, it is still a manual exercise to position the camera exactly perpendicular with respect to the crack.

Furthermore, there seems to be an information gap between inspection equipment manufacturers and inspection contractors. For instance, a pipe inspector once commented that the technology is so accurate that it can measure 1/32 inch on an extended tape measure. This seems very accurate, right? It is not accurate if the operator knew the measurement in advance. In an actual field inspection, an inspector will not have the benefit of knowing the crack width ahead of time, nor have the clean, straight-edged gradation of a tape measure. Furthermore, 1/32 inch, or 0.03 inch, is at least three times larger than the majority of the cracks one would encounter in an in-service concrete storm pipe. It is unfair to expect an inspector to report on the width of a crack one fifth of the thickness of a dime or less when experience suggests that this is not currently practical. Crack measurement demonstrations and review of post-construction pipe inspections have indicated that measuring crack widths of 0.05 inch and smaller is inaccurate and unreliable.

Licensed professional engineers who rely on accurate crack measurement reports can often be misled into mandating costly repairs for exaggerated crack widths otherwise not required. Pipe utility contractors can be financially penalized if decisions are based upon inaccurate information.

Ideally, the pipe inspection industry will need to address the issue of practical accuracy of crack measurements through education and/or training. Perhaps a disclaimer about accuracy in the inspection reports, or an accuracy range stated rather than an absolute value can better advise engineers on the level of confidence regarding accuracy. Another consideration may be the requirement of blind test demonstration in order to better assess the practical accuracy and repeatability of individuals performing crack measurements. By addressing the practical accuracy of crack measurement, NASSCO and the pipe inspection community can take action in ensuring the credibility and future of the pipe inspection profession.

References

1. This article is based on the May 2011 NASSCO Times article "What is the Practical Accuracy of Crack Measurement in Concrete Pipes?" by Doug Holdener of Rinker Materials Concrete Pipe Division - CEMEX. http://nassco.org/publications/times/0511.pdf
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