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A method for mechanical property assessment across butt fusion weldedpolyethylene pipes

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Abstract: The use of high-density polyethylene pipes in gas and water distribution networks is steadily growing worldwide. If the resistanceof plain pipes is at present time well established using appropriately designed standards, welding issues continue to be globallyapproached equally in terms of structure and mechanical properties. Consequently, further practical investigations should beaimed at studying mechanical properties in the weld region which includes the melt zone and its heat-affected zones. This workpresents a method based on removing layers in order to assess localized variances in mechanical properties throughout the weldseam in both radial and circumferential directions. An experimental plan based on specific machining operations allowed testing39 standard specimens representing the weld volume matter in three concentric layers for given pipe dimensions and theircounterpart standard unwelded ones. The typical stress–strain behavior of semi-crystalline materials is preserved in weldedand unwelded specimens but with different characteristic limits. At the weld inner layers, properties such as elastic modulus,yield, and failure stresses displayed lower values, whereas in welded outer layers, the tendency is inversed. The cold drawingextend remained approximately steady for unwelded and welded cases across the pipe wall. This property is less affected by thepresence of the weld as it described a constant material flow which is mostly a function of available material quantity for yielding.The approach developed in this study gives consistent indications on welding quality around the pipe weld and across thethickness. Accordingly, outermost and innermost welded layers may exhibit lower or even bad-quality welds as imperfectionscan concentrate stresses at the joint interface because of cold weld problems. Such method enabled detecting 23% of failures atthe weld seam from outer and inner layers while the middle layer did not reveal any failure at the weld. The causes of thisbehavior are approached using crystallinity evolution in welded and unwelded pipes.

Keywords : HDPE pipe . Butt fusion welding . Mechanical properties . Radial direction . Circumferential direction . St ru ct ur al variances