PVC PIPE ASSOCIATION
TECHNICAL BRIEF

PVC PIPE ACCOMMODATES DYNAMIC GROUND MOVEMENT

Underground piping systems are at risk from ground movements, usually from some combination of weather, geologic, and seismic conditions. Some movement is slow (erosion, soil subsidence), some is intermittent (freeze/thaw and wet/dry cycles), and some is rapid (landslides, earthquakes).

POTENTIAL PROBLEMS

Ground movement can cause complicated effects on pipelines:

- Longitudinal movement (parallel to the pipeline) can either push pipe joints together or pull them apart.
- Lateral movement (perpendicular to the pipeline) causes flexural stress in pipe walls as well as stress or movement in pipe joints.

GASKETED PVC PIPE PROVIDES SOLUTIONS

When ground displacements are large enough, no piping system will be able to withstand the resulting stresses and/or joint movements. However, PVC pipe has been an effective choice for the following reasons:

- Pipe barrel flexibility – all PVC pipes are able to bend longitudinally to accommodate some degree of ground movement
- Allowable joint movement – gasketed slip-on joints provide deep-socketed bells that are able to accommodate some movement
    - o Laterally – angular joint deflection
    - o Longitudinally – in both directions (joints pushing together and joints pulling apart)

WHEN THE EARTH MOVES, IT IS BETTER TO BE FLEXIBLE

A report titled "Behavior of Plastic Pipe Systems in Response to Dynamic Ground Movements" referenced more than 100 independent sources from around the world. The conclusion was: "The performance of flexible plastic pipe systems to withstand the stresses and strains of dynamic ground movements far exceeds the same ability of rigid, non-plastic pipe materials."

EARTHQUAKES: PROOF OF PVC PIPE'S PERFORMANCE

Proof of PVC pipe's performance is shown in the experience of utilities in actual earthquakes:

- **United States: Northridge, CA 1994 (Magnitude 6.7)**: A paper by Abercrombie summarized Valencia's PVC water pipe experience: "PVC pipe, which accounts for over 60% of our system, performed much better [than other materials]. We experienced no mainline breaks on PVC piping." The reasons for PVC's success: "Flexibility and insertion length play key roles."
- **New Zealand: Christchurch 2010/2011 (Magnitude 5.3 to 7.1)**: Christchurch was hit by six strong earthquakes over a 14-month period."
    - o *Water pipe*: Cubrinovski reported that PVC performed very well — only 1.8% of its length was affected, with AC at 6.1% and steel at 8.9%.
    - o *Sewer pipe*: O'Callaghan indicated that PVC gravity sewer pipes and fittings are now widely used in Christchurch for new subdivision developments and for network rebuild. Clay and earthenware pipes are no longer used, including for industrial lines where PVC has been adopted.

PVC PIPE: AN EXCELLENT CHOICE FOR GROUND-MOVEMENT AREAS

Utility pipelines need to remain intact and to function properly when the ground moves. The evidence favors PVC pipe due to:

- Movement-accommodating joints
- Ability to bend
- Available joint-restraint systems

References: "Behavior of Plastic Pipe Systems in Response to Dynamic Ground Movements," The European Plastic Pipes and Fittings Association (2017); "Handbook of PVC Pipe: Design and Construction," Uni-Bell PVC Pipe Association (2013); "Liquefaction Impacts in Residential Areas in The 2010-2011 Christchurch Earthquakes," Cubrinovski et al (2013); "Northridge Earthquake: A Review of the Performance of Various Water Main and Service Line Materials," Abercrombie (2013); "Pipeline Performance Experiences during Seismic Events in New Zealand, 1987 to 2015," O'Callaghan (2015)

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