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Designing Offshore Pipelines Facing the Geohazard of Active Seismic Faults

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Abstract : Nowadays, the exploitation of hydrocarbons reserves in deep seas and oceans, in combination with the need to transport hydrocarbons among countries, has made the design, construction and operation of offshore pipelines very significant. Under this perspective, it is evident that many more offshore pipelines are expected to be constructed in the near future. Since offshore pipelines are usually crossing extended areas, they may face a variety of geohazards that impose substantial permanent ground deformations (PGDs) to the pipeline and potentially threaten its integrity. In case of a geohazard area, there exist three options to proceed. The first option is to avoid the problematic area through rerouting, which is usually regarded as an unfavorable solution due to its high cost. The second is to apply (if possible) mitigation/protection measures in order to eliminate the geohazard itself. Finally, the last appealing option is to allow the pipeline crossing through the geohazard area, provided that the pipeline will have been verified against the expected PGDs. In areas with moderate or high seismicity the design of an offshore pipeline is more demanding due to the earthquake-related geohazards, such as landslides, soil liquefaction phenomena, and active faults. It is worthy to mention that although worldwide there is a great experience in offshore geotechnics and pipeline design, the experience in seismic design of offshore pipelines is rather limited due to the fact that most of the pipelines have been constructed in non-seismic regions (e.g. North Sea, West Australia, Gulf of Mexico, etc.). The current study focuses on the seismic design of offshore pipelines against active faults. After an extensive literature review of the provisions of the seismic norms worldwide and of the available analytical methods, the study simulates numerically (through finite-element modeling and strain-based criteria) the distress of offshore pipelines subjected to PGDs induced by active seismic faults at the seabed. Factors, such as the geometrical properties of the fault, the mechanical properties of the ruptured soil formations, and the pipeline characteristics, are examined. After some interesting conclusions regarding the seismic vulnerability of offshore pipelines, potential cost-effective mitigation measures are proposed taking into account constructability issues.

Keywords : offhore pipelines, seismic design, active faults, permanent ground deformations (PGDs)
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