ABSTRACT

The current status of strain-based design in China and the main aspects of China’s Second West-East Gas Pipeline project are introduced. It is evident that this pipeline needs to be designed using strain-based design as it crosses many seismically active faults. This paper introduces codes for pipeline design in seismic areas. A comparison between Chinese and Japanese codes reveals some inconsistencies and potentially problematic areas. The strain capacity of both conventional X80 and high deformation X80 pipes is compared. The allowable strains of the Second West-East Pipeline are calculated using the Chinese code and empirical equations. The feasibility of strain-based design for this planned X80 pipeline is demonstrated. The unresolved issues of strain calculation are highlighted.

KEYWORDS: natural gas pipeline, strain capacity, X80, seismic design

THE SECOND WEST-EAST GAS PIPELINE

The main line of the second west-east gas pipeline starts from Xinjiang autonomous region, crosses Gansu, Ningxia, Shanxi, and Henan provinces, and ends in Hubei province. Two branch lines start from Hubei and end in Shanghai and Guangzhou, respectively. The total length is about 7000 km (4375 miles). The main line has a diameter of 1219 mm (48 inch), a design pressure of 12 MPa (1740 psi), and steel grade of X80. The branch lines have a diameter of 1016 mm (40 inch), a design pressure of 10 MPa (1450 psi), and steel grade of X80. The wall thickness is listed in Table 1 by area classification. The pipeline will cross 600 km (375 miles) seismic areas with peak acceleration of 0.15 m/s², and 700 km (438 miles) of 0.2 m/s². It will cross or be close to 30 active faults.

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Area classification</th>
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<tbody>
<tr>
<td>1219</td>
<td>1 22 26.4 33</td>
</tr>
<tr>
<td>1016</td>
<td>12.8 15.3 18.4 23</td>
</tr>
</tbody>
</table>

STRAIN-BASED DESIGN IN CODE FOR SEISMIC DESIGN OF OIL AND GAS STEEL PIPELINE

In China, the seismic design code was issued 15 years ago. It was revised in 2004. Some problems have been found when using the code for strain-based design.

Main Provisions in SY/T 0450-2004 Code for Seismic Design of Oil and Gas Steel Pipeline

General Requirements

a) This code is applicable to seismic designs of oil and gas pipelines in area with peak acceleration of 0.05g-0.4g. When pipeline crosses areas with peak acceleration of more than 0.4g or special seismic requirements are needed, special studies shall be carried out.

b) Pipeline site shall be classified into three types: stiff, normal, and soft. Site characteristics can refer to Table 2. In the table, the first, second, and third group can be determined according to GB50011 Code for seismic design of buildings.

For the planned second West-East pipeline, however, the above referenced codes are not enough, as high strength large diameter X80 linepipes will be used. The procedure of computing strain demand and capacity is no longer suitable. To apply the strain-based design in the second project, strain demand and allowable strain of the X80 pipeline is discussed in this paper.