

High Risk Landslide Analysis, OCENSA Pipeline, Colombia

by Jonathan Motherwell,
Dames and Moore, Inc.

The new OCENSA pipeline now connects the Cusiana oil fields in central Colombia to an offshore tanker loading facility at the port of Coveñas on the Caribbean Sea. The 780 km long pipeline will ultimately transport 320,000 barrels per day. The pipeline is constructed of 30 and 36 inch, Grade X-70 steel pipe with a wall thickness of up to 0.812 inches. A 218 km section of the pipeline between the pump station at El Porvenir and the pressure regulation station at La Belleza crosses rugged Andean mountain terrain. Along this section, eight zones were identified which pose potential landslide hazards to the pipeline.

OCENSA (Oleoducto Central S.A.) is a joint stock company consisting of the oil field developers and several pipeline companies. Dames & Moore was contracted by OCENSA to assess the landslide risk to the pipeline in each zone and to recommend remedial measures, if necessary.

First, a series of field reconnaissances were undertaken to identify individual landslide-risk sites within each zone. Then, for each site, a geological and geotechnical evaluation was performed. Site evaluations included topographic and geologic mapping, hydrological studies, subsurface exploration, field and laboratory testing, slope stability analyses, and the installation of piezometers, slope inclinometers and survey monuments.

Ideally, landslide risk could have been computed from a probabilistic point of

view. However, probabilistic analysis requires a very significant amount of data. It would have been prohibitive from a schedule point of view to obtain enough geotechnical data to choose an appropriate probability distribution function and to accurately compute standard deviations of the relevant parameters. For this reason, landslide risk to the pipeline was assessed using a factor of safety approach in conjunction with engineering judgement.

The landslide risk to the pipeline at each site was categorized as low, moderate, or high. This ranking was based on the following factors:

- Assessment of the potential for damage to the pipeline from a possible landslide.
- The computed factor of safety of the slope.
- Assessment of the likelihood that geotechnical conditions might change significantly during the operating life of the pipeline.

After assessing the landslide risk and developing remedial options, a field monitoring and inspection plan was developed for each site.

BIOGRAPHICAL SKETCH



Jonathan Motherwell has been vice president of Dames & Moore for the past eight years. He is general manager of the firm's Latin American region. As manager, he is responsible for the firm's business from Mexico to Argentina.

He has over 20 years of technical and managerial experience with large-scale engineering projects related to oil and gas, mining, power, and chemical manufacturing industries in the United States, Latin America, Europe, and the Middle East. Mr. Motherwell received a Master of Science in engineering from the University of Texas at Austin and a Bachelor of Science in civil engineering from the University of Missouri-Rolla. He is a registered professional engineer in four states, including Texas.

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