Engineering
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TRANSMISSION PIPELINE SUBSIDENCE FROM MINING

PROBLEM

In many areas, longwall mining is ruling the day in underground coal and other ore deposit extraction. Over the years, this extraction method has advanced and become a more productive process. As a consequence of this, and increased mining in areas with greater infrastructure, there has been greater exposure of transmission pipelines to ground movements from longwall mining.

Longwall mining can typically subside the ground up to 4 to 7 ft. with corresponding lateral displacement from 1 to 2 ft. As successive panels of coal are fully extracted, they will be accompanied by successive events of subsidence, exposing any overlying pipeline(s) to such movements. Such events are depicted in general terms in Figure 1.

INDUCED PIPE STRESSES

Because of the nature of the subsidence event, a buried pipeline would most commonly be exposed to bending and axial stresses. This is depicted in Figure 2. As a rule of thumb, the deeper the mine is the less induced ground curvature there will be and the greater the breath of lateral movement (assuming similar site conditions). This in turn means smaller bending and greater axial components of induced pipe stress as the mine becomes deeper.

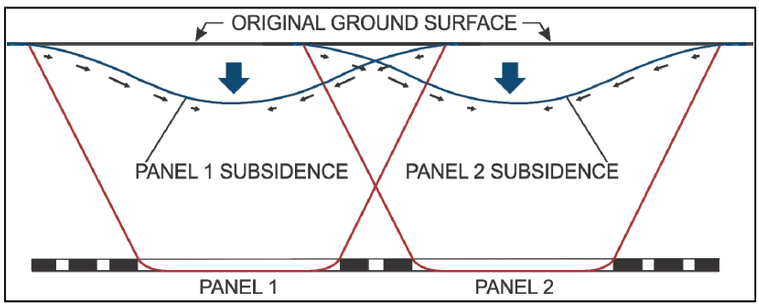

FIGURE 1: LONGWALL SUBSIDENCE GROUND MOVEMENTS

Due to the complex set of conditions presented, the prediction of pipe stresses and the assessment of the ability of the pipeline to sustain subsidence movement requires computer analysis (See Figure 3). Important pipeline information required for the stress assessment includes operating pressure, allowable stress, dimensions, condition, burial depth, bends, and service and valve connections. Other relevant data includes backfill conditions and possible surface topography (e.g. sloped ground).

Field jacking tests may be merited to assess the slip resistance where significant axial stress is anticipated.

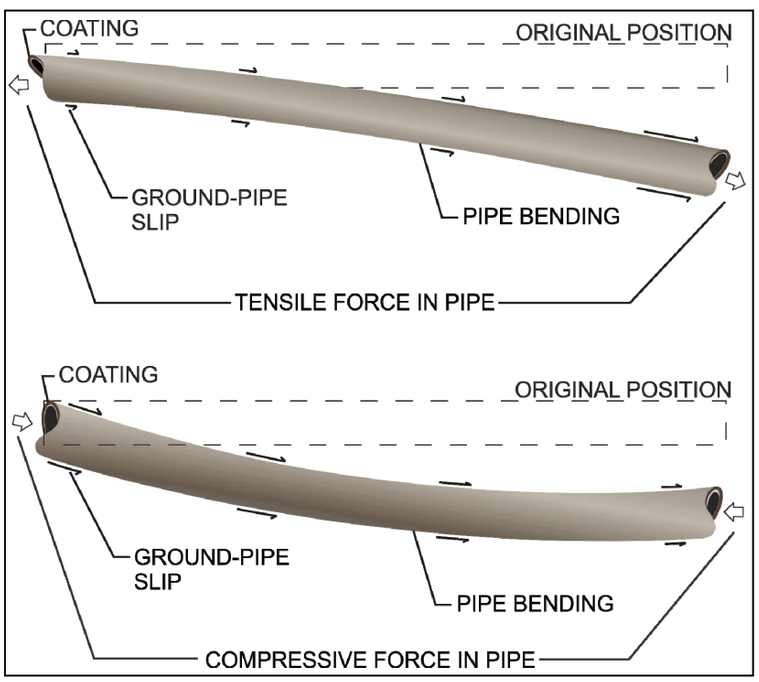

FIGURE 2: TYPICAL LONGWALL SUBSIDENCE INDUCED PIPE STRESSES

MONITORING PIPE STRESS

Stresses induced in transmission pipelines are a dynamic condition. As the overlying longwall mining proceeds, the accompanying surface movement affects the pipeline at a different stress intensity and location. Therefore, real time measurements of pipe stress are required. This is done with strain gauges which are welded to the pipe. The strain gauge readings can be sent remotely via radio transmission to a central data collection system where the data is conveyed

(continued on back)

to the user by phone line or internet. (See Figure 4).

MANAGING PIPE STRESSES

Depending upon the expected level of pipe stress, mitigation measures may be taken prior to subsidence. There are a number of mitigation measures which can be utilized that basically decouple the pipe to some degree from the ground. Whether mitigated or not, an emergency plan needs to be in place to relieve the unanticipated pipe stress. This plan usually consists of different actions needed when pre-established threshold levels are reached.

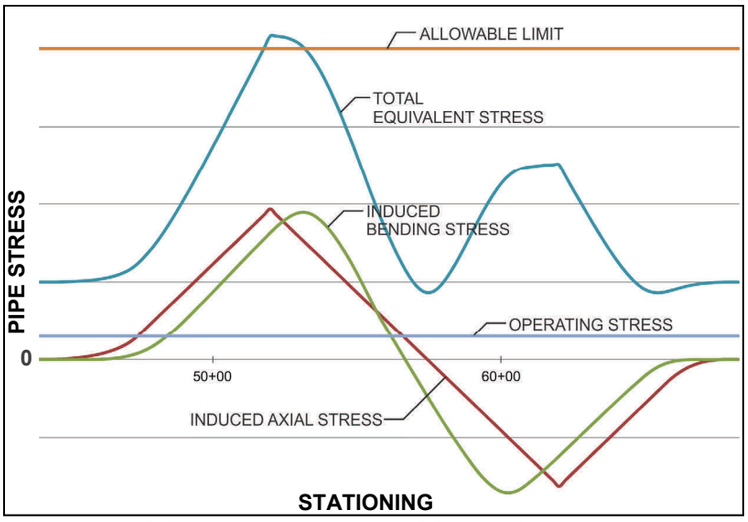

FIGURE 3: COMPUTED PIPE STRESS INDUCED BY SUBSIDENCE

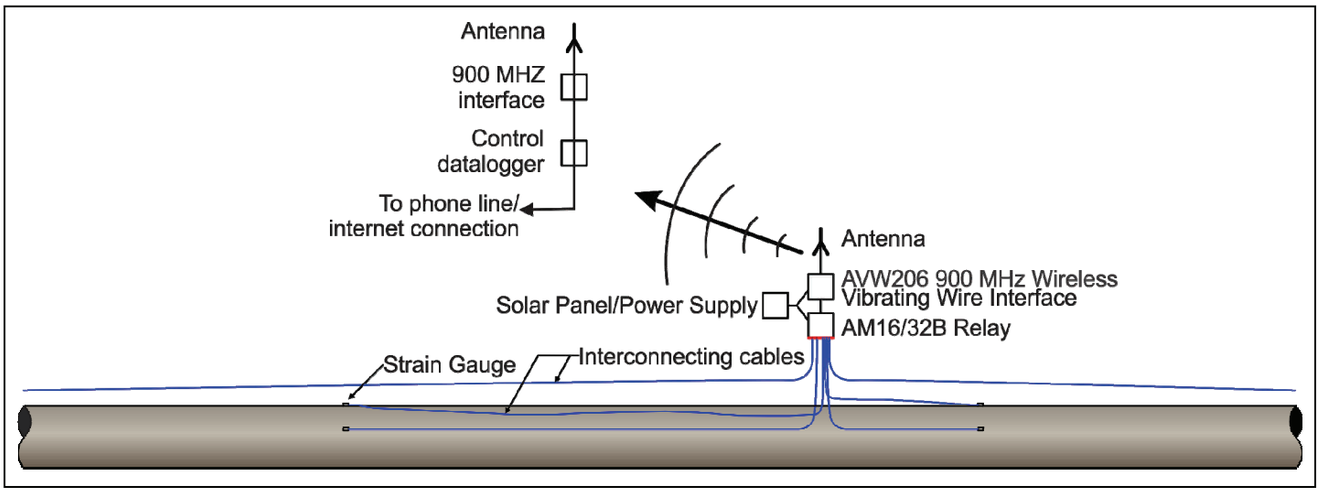

FIGURE 4: STRAIN MONITORING SYSTEM

SUMMARY AND CONCLUSIONS

Future exposure of transmission pipelines to longwall subsidence should be addressed 2 to 3 years in advance of subsidence. Contractual issues are often difficult to resolve between the parties. This is more of a concern for the mining company, as they are on a timeline and delays in the negotiations between parties regarding responsibility can ultimately affect the resolution reached.

In the future, exposure of transmission pipelines to longwall subsidence is expected to be more commonplace. The most cost effective solution to handling related pipe stress considers the specific site conditions and applies the appropriate mitigation measures, if needed. It also should include a closely coordinated monitoring plan. There are different measures available to manage or mitigate the subsidence induced stress.

Other Engineering UPDATES of Interest:

UPDATE 4: Improvement of Mine Support Saves Pipeline from Subsidence Event

UPDATE 14: Establishing Mine Subsidence Risk

UPDATE 1: Successful Deep Mine Backfilling to Mitigate Mine Subsidence

ABOUT MEA: Marino Engineering Associates, Inc. focuses on engineering research, practice and expert evaluations and is licensed in 24 states in the U.S. Our projects primarily have an emphasis on Geotechnical Engineering, however, we also have significant experience in projects involving transportation, subsidence engineering, laboratory testing, training, and geophysical exploration. Gennaro G. Marino, Ph.D., P.E., D.GE is president and principal engineer of Marino Engineering Associates, Inc., and has been a licensed professional engineer since 1984. To obtain additional information on MEA, one can also visit our website at www.meacorporation.com.

FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact Dr. Marino at the address listed below.

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