INFLUENCE OF MINING SUBSIDENCE ON PIPELINES

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Summary

In county Durham, North-east England, a high pressure, natural gas pipeline runs in an infilled trench just west of Sunderland south south-eastwards to Peterlee and beyond. At two localities sinkholes have developed on or adjacent to the pipeline. In addition to the regular inspection of the pipeline route, constant surveillance of these problem areas is maintained in case remedial action is needed.

The pipes are buried in trenches cut through glacial tills. At rock head are Permian magnesian limestones up to 140 metres thick resting unconformably on Coal Measures within which up to 7 metres of coal has been extracted from up to 7 seams. The deepest worked seam is 440 m below ground level.

It is demonstrated that the sinkholes are associated with the limits imposed on coal extraction by old property boundaries, coked zones adjacent to basic dykes, and faults. A zone of maximum tensile strain occurs at the surface in these locations. It is postulated that the strain is taken up by opening of a few master joints in the limestones and the coal measures below. Ground water circulation down through the till leads to the upwards migration of the existing tension gash until collapse of the surface occurs giving rise to the so-called sinkholes.

Introduction

In the Northumberland and Durham Coalfield of North-east England, the southeastern part is concealed beneath Permian strata. Up to seven coal seams have been worked in the Coal Measures. Locally, the lateral extent of workings in any one seam or group of seams may have been limited by barriers of one kind or another. Such barriers include old property boundaries, normal faults offsetting the succession, and intrusive basic igneous dykes that have locally converted the coal seams to unworkable coke.

Limitation of the extent of coal working has a very important influence on both the localisation and permanence of subsidence effects in the overlying Coal Measures and the Permian limestones caused by removal of up to seven metres of coal. These subsidence effects, as will be demonstrated, have had an important influence at the present topographic surface on the ground support afforded to high pressure, steel gas pipelines embedded in shallow trenches in glacial till. The 18 in (450 mm) pipe, laid in 1964-65, is the East Coast Grid high pressure pipeline running from Blyth to Darlington. It is crossed at Warden Law by the Edmondsley Sunderland 12 in pipeline running approximately parallel to the B1404 road.

The area of interest lies to the south-west of Sunderland (fig. 1) where the pipeline leaves the A108 Trunk Road, skirting East Haining and Warden Law to continue south-south-east towards Westmoor Farm near Peterlee. At the three named localities so-called 'sinkholes' occur near to, or on the pipeline route. The sinkholes are active, and each year localised depressions in the fields are infilled by the farmers. There is a risk that the gas pipelines will become exposed, and perhaps locally unsupported, from time to time.

The local geological setting

Coal measures have been worked beneath an unconformable cover of Permian limestones to depths of over 400 metres from the surface. Thickness of the limestones varies locally from seventy to one hundred and forty
metricals including up to ten metres of basal Yellow Sands. Generally there is a thin cover of glacial till and locally sands and gravels (Smith and Francis, 1967).

At Warden Law (fig. 1) the local succession of interest is 440 m deep (fig. 2). Nine metres of glacial till are underlain by the Magnesian Limestone and Yellow Sands to a depth of 71 m. The first worked coal, the Five Quarter, is at a depth of 266 m, and down to 440 m, the local level of the Busty Seam, another six seams have been worked. Up to seven metres of coal have been extracted.

At Westmoor Farm (fig. 1) the lowest worked seam, the Harvey (fig. 3) is at a comparable depth, but the details of the succession are different. Very thin till rests on 140 m of limestone and sand with the highest worked seam, the Ryhope Five Quarter, a short distance below the base of the Permian. Seven seams have been worked, with a maximum total extraction of six metres, in the area.