GEOLOGICAL INVESTIGATION OF SITES FOR A PROPOSED M42/M1 MOTORWAY BRIDGE CROSSING, NEAR STANTON-BY-DALE, DERBYSHIRE

by

D. S. Buist and F. M. Taylor

Summary

The geology of alternative sites for a bridge crossing for the proposed M42/M1 intersection are described. The results of the first investigation suggested the possibility of old coal workings in the north of the site, artesian water and shattered rocks in the south and a varied lithology for the foundation over the site generally. The second site, 300 m to the south, is underlain by a more constant lithology for the foundations and there is an absence of complex structure; it is therefore to be preferred.

Introduction

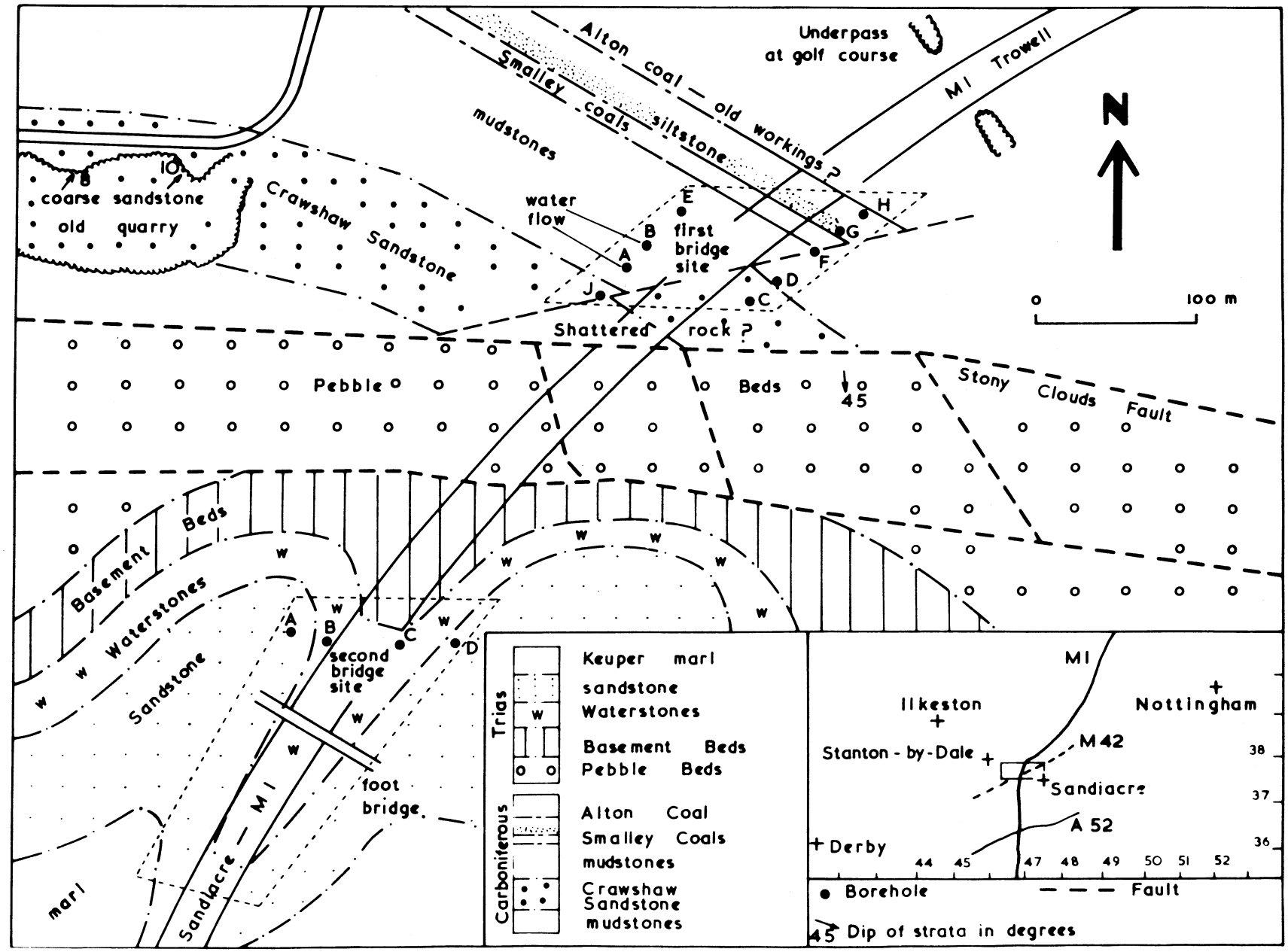
The possible route of the M42 Nottingham to Birmingham Motorway, as outlined by the Midland Road Construction Unit in 1971, would entail the construction of a number of major bridges, one of which would span the M1 motorway between the Trowell Service Station and M1 exit 25 (A52 crossing) in the vicinity of the Erewash Golf Course (SK 477378), close to the village of Stanton-by-Dale, near Sandiacre, Derbyshire. A detailed geological survey was initiated because of the known occurrence of a major east-west fault, the Stony Clouds Fault, separating Coal Measures rocks to the north from Permo-Triassic strata to the south. The area was geologically surveyed by the authors on the 1/2500 scale, information being available from the original M1 survey (Le Grand Adsco 1962), from publications which resulted from the M1 excavations (Taylor 1965; Frost 1968) and from nine new boreholes (A - J) drilled for the present survey. Information was also obtained from trench excavations along the west margin of the M1, which were dug for a mains water pipe-line for the City of Nottingham Water Department in 1968 and recorded at the time by Mr. A. E. R. Houldsworth.

Text-fig. 1 is a reduction from the completed 1/2500 plan and indicates the geology of the area and the position of two possible bridge sites; the first, situated north of the major fault, is entirely underlain by Coal Measures strata and the second one, currently under consideration, is on Permo-Triassic rocks. Text-fig. 2 summarises the rocks found in the area.

Site 1; 200 m south-west of the Erewash Valley Golf Course M1 underpass (SK 475368)

Situated entirely on Coal Measures rocks, this location was considered to lie north of the Stony Clouds Fault and south of the outcrop of the lowest potentially exploitable coal seam, the Alton Coal. The site should therefore be free from old coal workings and would avoid the extensive rock fracturing that might be found close to the main fault. The geological sequence below the Alton Coal proved to be mainly mudstones and siltstones with thin weathered coals, possibly the Smalley Coals. A layer of mudstone containing the brachiopod shell, *Lingula* sp above the upper of these two coals proved a convenient marker horizon in some of the boreholes. The Coal Measures sequence ends with the Crawshaw Sandstone, a coarse-grained rock up to 32 m in thickness. In the borehole cores of this rock, the iron oxides had not been oxidised and it was light to medium grey in colour. The base of the sandstone was not attained in the boreholes.

Mercian Geol. Vol. 5, No. 3, pp. 175-180, 2 text-figs, Plates 9 and 10



Text-fig. 1. Geological plan of proposed M1/M42 bridge sites

It can be seen from text-fig. 1 that the alignment of the bridge, at approximately N 80°E, would differ from the strike direction of the rocks at N 135°E by 55°. The maximum inclination of the rocks is 25°, direction N 45°E, whilst the dip is frequently about 10°. This, considered with the varied rock types of the Coal Measures mentioned above, means that there would be no constant lithology for any of the bridge pier footings. On the west side of the site, the Crawshaw Sandstone is the most suitable founding material, but the rock can only be located close to the surface at the southern end; at the northern end the sandstone could be up to 30 m below ground level. The rocks above this sandstone are mainly weathered clays. On the east side of the motorway, a compact siltstone or fine sandstone was located in boreholes G and H, at the north end of the east pier, but a thin, weathered coal separated the rock into two thin layers. These rocks could not be located at the south end of the pier position, where boreholes D and F contained the mainly weathered clays, considered to occur above the Crawshaw Sandstone, which was encountered in borehole C. It was concluded that a fault separated boreholes F and G; the shattered state of the rocks in borehole F suggested that the fault would be close to this position.

On text-fig. 1, this fault has been drawn across the motorway to borehole J, which after considerable difficulty in drilling produced a core of shattered black mudstone with highly polished shear faces. It is considered that this borehole is situated too far north for it to have encountered the Stony Clouds Fault.

The shattered, weathered mudstone from borehole J may well have formed an hydraulic barrier for water draining from higher ground to the west through crevasses and pore spaces in the Crawshaw Sandstone, for artesian water conditions were proved in boreholes A and B. Although nothing in this water, or ground water from other boreholes indicated potential sulphate attack on concrete, some joint surfaces of the Crawshaw Sandstone were coated with gypsum, which suggests that sulphate resistant concrete should be used in any foundation work on this site.

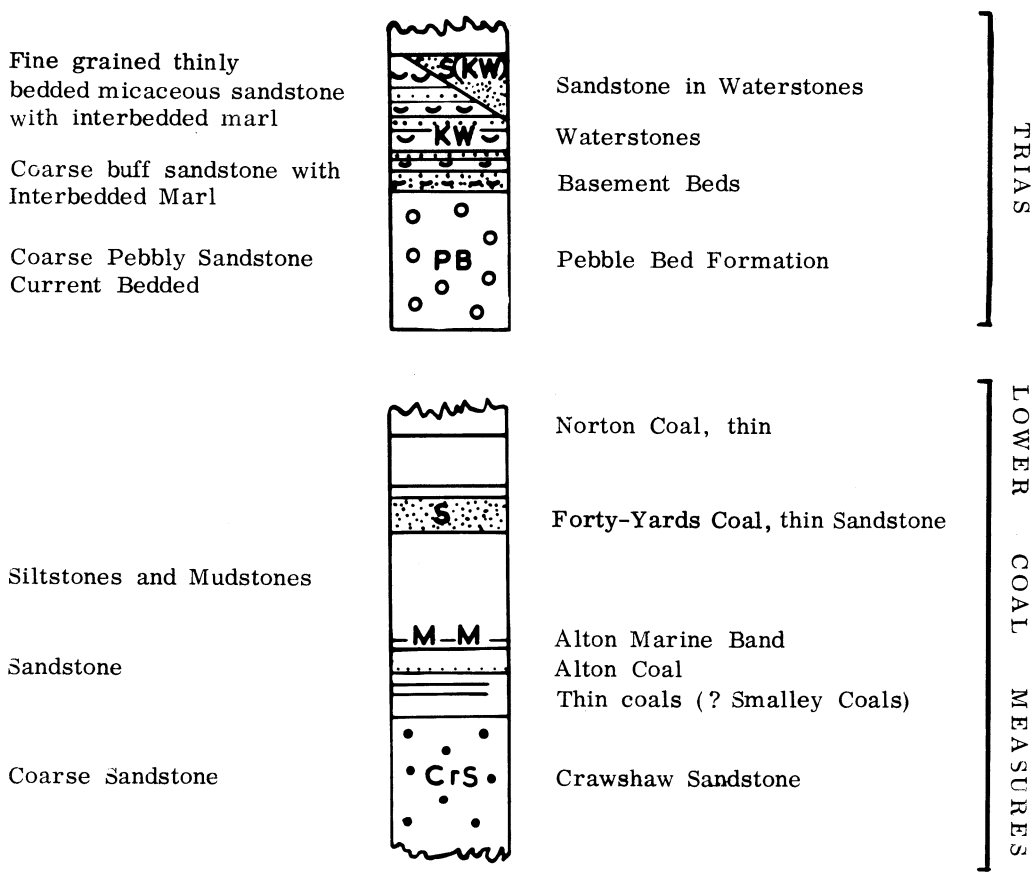
Thus, although the general geology of the area indicated initially that a possible site occurred at this point, the subsequent detailed investigation proved that foundation engineering would be complex. There would be not only the risk of constant flooding of the site but also of failure to locate consistently competent strata on which to build the bridge foundations. A second site, some 300 m to the south-west, was therefore investigated.

Site 2; close to the accommodation footbridge (SK 472375)

During the construction of the M1 Motorway, the Triassic rocks immediately south of the Stony Clouds Fault were exposed in a deep cutting and the details recorded. In particular, it was noted that the Waterstones Formation contained thick fine-grained compact sandstones with a minimum amount of interbedded marl. The sandstones and marls were essentially unweathered below a position 5 m from the original surface. The site investigation boreholes of this site (A - D) confirmed the original observations.

The sandstones should form excellent strata for all the foundations of the M42 bridge and the Waterstones Formation below, consisting of thin sandstones and marls, would also be suitable. If necessary the foundations could go deeper to the level of the Pebble Beds but, as the higher rocks are unweathered, the deeper foundations are unneceessary. There were no faults recorded from the area outlined on text-fig. 1 as the second bridge site, and there were no water problems.

Optimum utilisation of the sandstone would mean that the bridge-crossing would be sited just to the south of the footbridge indicated on text-fig. 1. This would mean that the line of the motorway would be undesirably close to a housing estate to the south-east. Advantage might be taken of the unweathered state of the marls and thin sandstones below the main sandstones to site the bridge north of the footbridge, keeping the motorway as far as possible from the houses. The road would be situated in a cutting at the closest point. The differences in



Scale 1 : 1250

Text-fig. 2. Generalised Vertical Section

shear strength of weathered and unweathered Keuper Marls and similar rocks is considerable, as noted, amongst others, by Chandler (1969) and it would be necessary to ensure that weathering of these rocks is kept to a minimum by sealing the foundations from surface-water and water which may gain access from the M1 cutting.

The unweathered Triassic rocks contain both dolomite and gypsum and sulphate resistant concrete would be essential.

Conclusion

Geological knowledge of the area of the Erewash Valley Golf Course, Sandiacre, along the line of the M1, suggested two possible sites for the proposed M42/M1 crossing. Detailed investigation indicated that the first site, on Coal Measures rocks, would result in complex and costly foundation engineering with problems of water, shattered rock, a mixed lithology and others to be solved. The second site, although closer to urban development, is, from the geological point of view, to be preferred, as foundation work would be restricted to the same lithology, with an absence of structural complications.

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D.S. Buist, M.A., M.Sc., Ph.D., M.I.C.E., F.G.S.,
Midland Road Construction Unit,
County Offices,
Matlock,
Derbyshire.

F.M. Taylor, Ph.D., F.G.S., F.I.M.M.,
Dept. of Geology,
The University,
Nottingham,
NG7 2RD.

EXPLANATION OF PLATES

Plate 9

fig. 1. General site area of M42/M1 first bridge site, taken from Stony Clouds (outcrop of Lower Triassic Pebble Beds in the foreground). The M1 motorway is in the centre of the photograph with the Erewash Golf Course, Club House and Stanton Iron Works beyond. The motorway underpass can be seen on the far right of the fig.

fig. 2. General site area of the M42/M1 second bridge site as proposed, to be sited to the right of the footbridge. Taken from Stony Clouds with the Erewash Golf Course beyond the M1 motorway cutting.

Plate 10

fig. 1. Stony Cloud outcrop of Pebble Beds from the Erewash Golf Course, looking east. The escarpment is controlled by a fault separating the Pebble Beds from Upper Carboniferous Rocks.

fig. 2. View from Stony Clouds looking approximately west. The thick belt of trees marks the position of the old quarry in the the Crawshaw Sandstone.

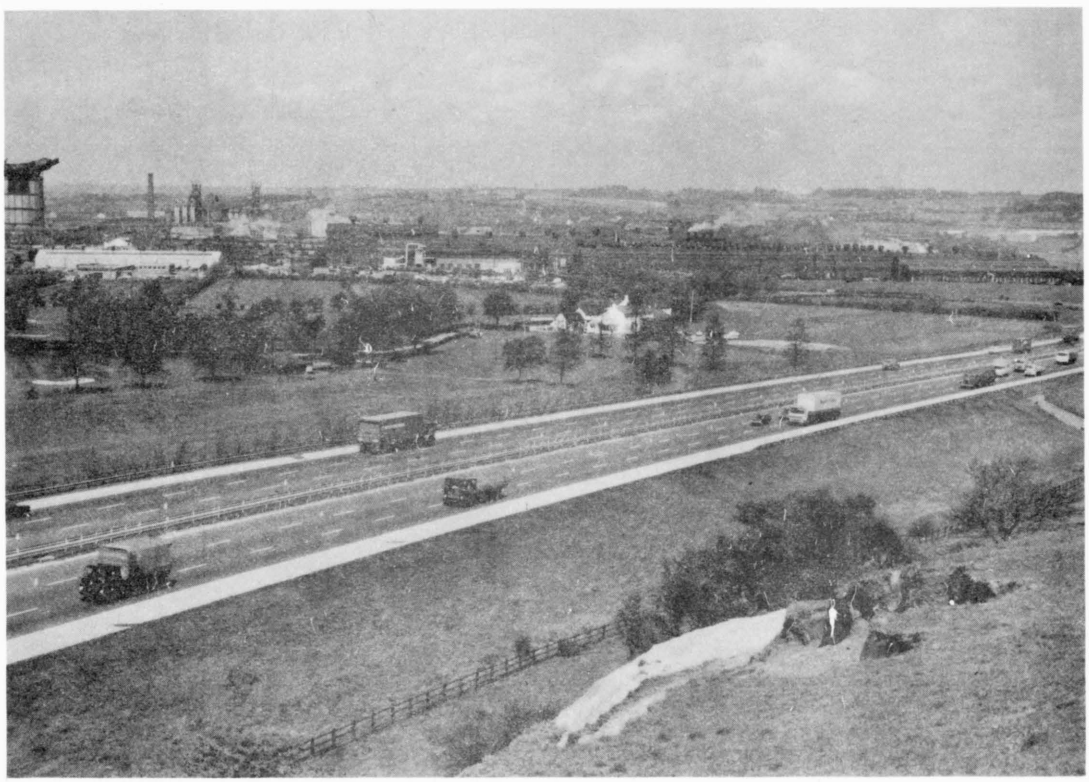

Fig. 1. First Bridge site.

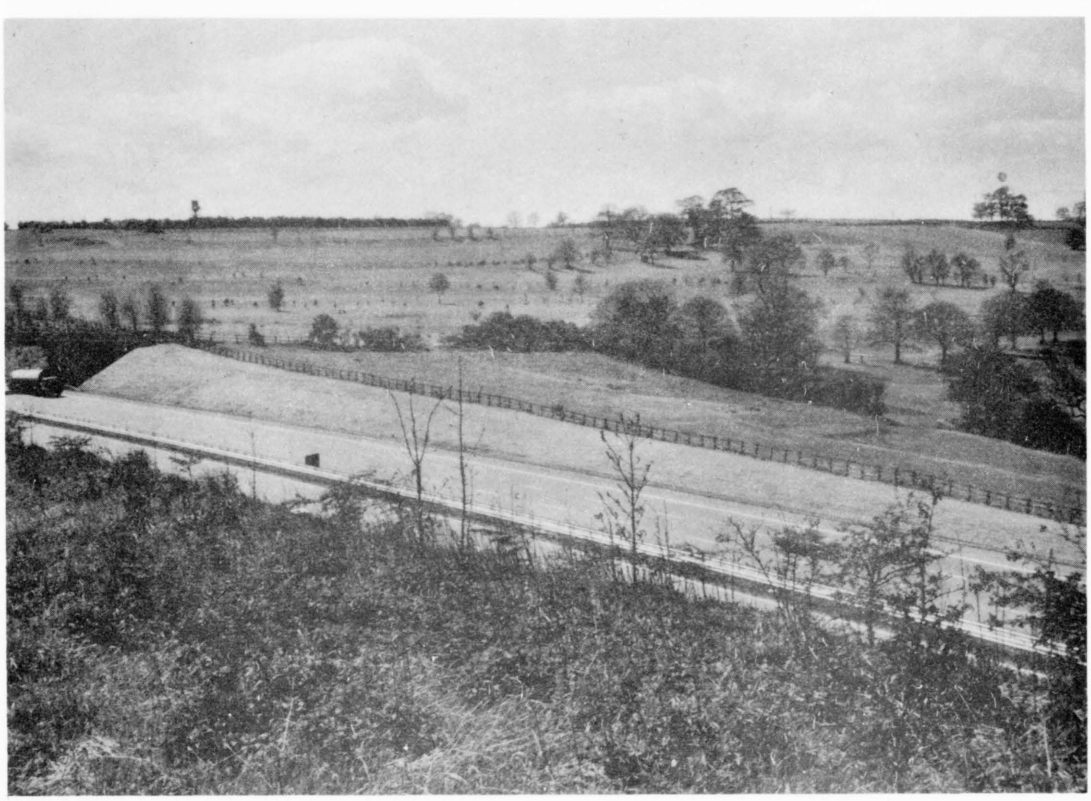

Fig. 2. Second Bridge Site.

Fig. 1. Stony Clouds, Sandiacre.

Fig. 2. Crawshaw Sandstone Outcrop, Stanton-by-Dale.