Mr. FOWLER said, that if strong mortar could be obtained, the hearting must contribute to the strength of the structure: the weight also was an important element. There was an extraordinary amount of strength in concreted masonry, of which the old Norman castles were examples. The stability of an arch of 70 feet span was insured by fitting the stones well together, and filling up with good mortar and hearting: the centering was left a longer time than usual, (and this was an essential point,) in order to insure the cohesion and concretion of the mortar.

Mr. SIMPSON, V.P., observed, that the impurities in the chalk lime of London constituted a large per-centage of the whole: this was, probably, due to its imperfect manufacture, much of the chalk remaining unburnt. He believed, that the badness of mortar was owing to the inferior quality of the lime employed.

Mr. C. MAY said, that if pure lime and pure silica were ground together and comminuted to the utmost fineness, they would produce an excellent mortar, but requiring time to become hard, the silica acted upon the lime and a silicate was formed. It was the time that had elapsed, which rendered the Roman mortar so hard. Lias lime contained a proportion of alumina. Some of the best mortar he had met with was made with chalk lime and the refuse burnt sand from a foundry: this sand was extremely fine and contained some alumina.

April 8, 1851.

WILLIAM CUBITT, President, in the Chair.

No. 848.—“Description of two Bridges over the River Don and the Canal, with the Lodge and Approaches, on the Estate of Sir Joseph Copley, Bart., at Sprotbro’, near Doncaster.” By HENRY CARR, Assoc. Inst. C.E.

THE village of Sprotbro’ is situated on the north bank of the river Don, and hitherto, the only means of communication with the south side has been by an ancient ferry, which, from being situated immediately above a weir was, in times of flood, either unavailable, or extremely dangerous and inconvenient. The fall over this weir is, in ordinary water, about 5 feet, but in extreme floods, to which the river is subject after heavy rains in the neighbourhood of its source, the lower level is raised 11 feet, or 6 feet above the crown of the weir, and 3 feet, or 4 feet above the adjacent meadows. A bridge across the river, with embanked approaches over the meadows, had long been a desideratum, and in the year 1848, the works, which form

the subject of the present communication, were undertaken by Sir Joseph Copley, Bart., and were completed in January 1850, having occupied fourteen months in construction.

The river Don at this part of its course, runs between precipitous ranges of limestone hills, from which a deposit of silt, about 30 feet in depth, forming meadows 200 yards in width, has taken place. It is rendered navigable in the ordinary manner, by weirs and short cuts, or canals, with the necessary locks. As one of these cuts occurred at Sprotbro', in the course of the proposed works, a bridge had to be provided for the navigation, as well as for the river.

The works consist of a new road, 264 yards in length, which skirts along the steep side of the hill, and falls, at the lower end, 1 in 25; it turns directly across the valley and forms the approach to the bridge over the river Don. This bridge is 300 feet in length, and the roadway is 24 feet above the ordinary water-level. An embankment 55 yards in length, and 12 feet in height, crosses the island formed by the river and canal, and connects the two bridges. The canal bridge crosses the navigation above the lock, and is 82 feet in length. A short piece of embankment connects this bridge with the public road leading from the village of Sprotbro' to the old ferry, and at the junction with the old road on the North side there are the lodge and gates. The total length of the new works is 536 yards, or nearly one-third of a mile.

The foundations of the abutments of the river bridge are on bearing piles 10 inches in diameter; they were driven until a monkey weighing 18 cwt., and falling 10 feet, did not move them more than three-eighths of an inch at a blow; ordinary pile shoes, each weighing 12 lbs., were used. The tops of the bearing piles were accurately cut off to a uniform level, and barks, or cills, 12 inches by 8 inches scantling, to which the planking was spiked, were attached to them. The piles under water are of larch, oak, or beech; those not under water are of larch, or oak; and the cills and planking are of oak. The sheet piling round the foundation consists of elm planking 4 inches thick, driven between gauge piles and walings, bolts $1\frac{1}{8}$ inch in diameter being passed through the walings and sheet piling, at intervals of 2 feet.

The bridge consists of one centre span of 100 feet, and three land arches on each side, each of 20 feet span. The centre arch is formed of four laminated timber ribs, each rib being composed of eleven planks 3 inches in thickness, giving a section of 2 feet 9 inches by 1 foot. The outside planks are scarfed, and the interior planks are set a slight distance apart at the butt ends, so as to allow of the whole being keyed up by driving in hard oak wedges, when

the arch was laid. The layers of planks are held together, at intervals of 2 feet, by spikes 8 inches long, and by bolts $1\frac{1}{2}$ inch diameter, at each of the spandril struts. It was at first proposed to use Ransome and May's compressed keys, for the wedges between the butt ends of the planks, but on Mr. May's recommendation, the hard wood was substituted. The objection to the ordinary method of laying the butt ends of the planks close against each other, was, that a certain amount of compression must take place before the joint can take its bearing, and where trenails are used instead of spikes, it is a question whether the thrust of the arch is not received and borne by the trenails, before the butt joints of the planks take their bearing. The Author believes, that a careful observation of the settlement on striking the centres of a laminated arch with butt joints, would be very useful. In the present instance, upon driving home the keys, no visible alteration was made, but on removing the lagging, the weight was found to be borne by the wedges, side-ways of the grain; but this is hardly so objectionable as the imperfection in the butt joint, in the ordinary method of construction. The planking of the roadway was spiked to the longitudinal bearers, caulked, and covered with 4 inches in thickness of broken furnace slag, mixed with boiled coal tar.

The masonry consists of tooled ashlar, pitch-faced ashlar, and rubble. The quoins, plinth, impost, stringing, coping, and caps of pilasters are of tooled ashlar, accurately dressed to the requisite mouldings. The coping stones of the parapet are fastened with pebble joggles. The pitch-faced ashlar is in courses averaging 14 inches in depth on the bed, and thoroughly bonded into the rubble backing; the beds and cross joints are dressed not less than 6 inches in depth from the face, and made as close as possible,—the face being left rough. The parapet, which is 1 foot thick, is of this material, and the stones are fastened together with large pebbles set in cement. The rubble work is thoroughly bonded, and all the hollows are filled up with small stone and mortar, in preference to grouting. Sandstone from the neighbourhood of Swinton, about six miles from the work, was used for this bridge, as the labour on the limestone of the immediate vicinity would have been very expensive. The mortar was composed of three parts of clean river sand to one part of fresh lime burnt in the ordinary kilns. The brickwork of the land arches consists of the best hard-burnt kiln bricks, uniform in colour for the soffits, and the whole is set in cement, composed of one part of Roman cement to one part of sand. The arches, piers, and abutments were covered with two coats of gas tar, and afterwards with a layer of stiff clay puddle.

Some little difficulty arose with the Canal Bridge, owing to an additional height of 7 feet 6 inches over that of one of the old bridges in the immediate neighbourhood, having been required by the Canal Company, after the commencement of the river bridge, and it led to some alteration in the style of the original design.

The foundations of this bridge are also on piles, 21 feet in length, the toes being 30 feet below the natural surface. The silt is of so loose a texture, that a greater number of piles were required, and when the tops were cut off, they were inserted as wedges. The masonry is laid on planking similar to the Don Bridge, the interstices between the cills being filled with broken stone, well rammed and grouted. The span of the arch is 54 feet, and the rise 10 feet 9 inches, or one-fifth of the span. The whole of the bridge is of stone, excepting the interior of the arch, and a portion of the interior of the abutment, which is of brickwork set in cement. The parapet is of pierced stonework, and the curve over the bridge is an hyperbola. The materials and workmanship of this bridge are similar to that over the Don, excepting that a hard grit stone was used for the face, on account of its exposure to injury from the masts of barges. Sir Joseph Copley's coat of arms is carved in stone on two of the spandrels, and his initials reversed and entwined in the other two. The model from which the coat of arms was carved, was well and boldly executed by Mr. Worrell, of London. The road is open without charge during the day, to foot passengers, and vehicles on springs, but a small toll is charged on carts and waggons without springs, and on all vehicles passing during the night.

The contractors for the works were Messrs. Thomas and John Waring, of Swinton, to whom great credit is due for the very satisfactory manner in which they executed the works. The cast-iron work of the brackets and hand-railing, as well as the entrance gates, was furnished by Messrs. Young and Co., of Edinburgh.

The following was the cost of the several works:—

	£	s.	d.
Road formation, earthwork, and fencing .	1,234	4	2
Don bridge	3,633	1	3½
Canal bridge	1,826	4	10½
Lodge and entrance gates	957	3	2½
Total cost of works .	£7,650	13	6½

The timber for the foundations was provided by Sir Joseph Copley from his own woods.

The Paper is illustrated by a series of twelve drawings, Nos. 4,514 to 4,525.

[1850-51.]

x