with confidence upon almost every work he had executed. Now, however, he had become bolder, and as he heard the general expression of opinion of the members, in favour of both the piles and the moorings, and their determination to employ them, he should feel perfect confidence in their skill, in adapting them to the numerous uses of which they were susceptible, and if, for fear of prolixity, he had not given in the Paper ample directions for executing the various works, he would, with permission, supply the omissions before it was published, and would give to the members any further information in his power, which was the least return he could make for the valuable suggestions that had been offered publicly, in the course of the discussion, and privately by almost all the eminent Engineers and Contractors whose attention had been directed to the subject.

No. 525.—“An account of the Maplin Sand Lighthouse, at the mouth of the River Thames.”* By John Baldry Redman, M. Inst. C. E.

THE mouth of the River Thames is intersected by numerous sand-banks, at its junction with the ocean; the principal entrances are, the Swin, or King's Channel, on the north, and the Prince's, Queen's, and South Channels, on the south side; the sands which separate these main channels are the East and West Barrows, Nob, Knock John, Sunk, Girdler, and Long Sands.

The Swin, or King's Channel, is probably the most frequented, though not by first-class ships; but all east-country craft, and the greater portion of the coasting and collier vessels pass through this channel; in fact, the traffic appears almost continuous, for in fine weather there is a complete succession of ships to the east and the west as far as the eye can reach.

This channel runs between the Maplin sand on the north, and the Mouse, and the East and West Barrows' sands, on the south; at the western extremity of the Mouse sand, the channel is marked by a floating light of that name; from this light downwards, the channel bears N.E. by E. to the southern point of the Maplin sand, which is about three miles below the Mouse light: the channel then takes a N.E. direction, and five miles below the Maplin lighthouse,

* This paper was read at the meeting of May 24, 1842, and a short abstract of it was published in the Minutes of Proceedings of that year (Page 150); but as it is particularly alluded to by Mr. Mitchell in the paper “On Submarine Foundations” (Page 118), it is printed at length, with the discussion upon it.

is situated the Swin Middle light, marking the extent of the western end of the Middle and Heaps sand, which forms the southern boundary to the outlet of the channel, running between the Swin Middle light and the Whittaker beacon, at the north-eastern extremity of the Maplin sand: this light also points out the entrance to the Burnham river. The Swin channel, at its junction with the ocean, takes nearly an easterly direction, running between the Gunfleet sand on the north, and the Middle and Heaps to the south. Thirteen miles to the eastward of the Swin Middle light, is situated the Sunk light, which marks the northern spit of the sand of that name, and is the southern boundary to the entrance common to the Swin and the Barrow-deeps channels.

From this sketch of the intricacies of the Swin channel, it will be evident how important it is, to keep up an efficient system of lighting in so frequented a passage.

The Mouse light of the Swin channel is about fifteen miles distant from Southend, and about twelve miles from the Nore light, which latter is situated at the eastern extremity of the Nore sand, and marks the entrance to the southern channels, between the Nore and the Warp sands.

To the south of the point of the Maplin sands, where the lighthouse now stands, the channel was formerly marked by a floating light, called the Sheers. In light vessels, the lantern encircles and slides upon the mast, and is raised and lowered by a crab and chain, and these vessels are rendered more conspicuous during the day by being painted of a bright red colour; and a globe, about six feet in diameter, formed of thin wooden ribs, connected together by belts of the same material, is placed at the top of the mast.

The Swin Middle light vessel differs from the others, as the lantern revolves round the mast, being worked by machinery, which is wound up every two hours. The establishment in these vessels consists of six, or seven men, who are relieved every two months. The light vessels afford a good light by night, and are floating beacons by day; but are liable to drift from their moorings, or to suffer damage from vessels running foul of them, as they are generally in the fairway of the channel. In the event of their breaking from their moorings, serious calamities are liable to occur to shipping,* and

* During the gales of the winter of 1841, the danger to which vessels are exposed in the event of floating lights drifting from their moorings, was most fatally and fearfully proved; for on the night of Sunday, 22nd November, the Brig "Mary," of North Shields, and seven others, were wrecked on the Sunk sand. They left Orfordness with a strong gale from the N.E., running for the Swin channel, being confident of making the Sunk light-vessel at the entrance

the expense of maintaining them is also a serious objection to floating lights.

The Sheers light was, from its situation, one of the most important in the Swin, or King's Channel, as it marked the south-eastern extremity of that large flat, called the Maplin sand, and consequently pointed out the bend in the channel; the establishment of a fixed light on the point of this sand was therefore considered a very desirable object by the Corporation of the Trinity House.

A deputation of the Elder Brethren of the Trinity House, accompanied by Mr. Walker, their Engineer, visited the spot in 1837, for the purpose of surveying the sand, and of ascertaining the best position for a fixed light; various soundings were taken at the time, and the observations were extended to the eastward, as far as the Sheers beacon, which is situated 40 fathoms N.E. of the spot chosen for the new building. This beacon served formerly to mark the southern extremity of the sand, which however growing out, or increasing, to the westward, was rendered comparatively of little use. At low water the stump of an old beacon, the predecessor of the present one, may be seen about 50 fathoms still farther to the eastward.

From these facts, the sand would appear to have extended gradually to the westward, supposing that these beacons, when erected, were so placed as to mark the full projection of the sand.

A boring was made, during this survey, at the south-eastern point of the sand, in order to ascertain its nature and density: this was carried down 27 feet below the surface of the sand, or 26 feet below low water. The sand was compact and hard, so that with an ordinary boring-rod, worked by four men, a depth of 6 feet was penetrated in half an hour, and beneath that depth the facility increased, as the sand appeared to become mingled with silt.

The sand, at the time of the survey, was, at the spot chosen for the lighthouse, from 12 inches to 18 inches above the level of low water spring tides, which here rise 15 feet, and it is high water at

of the channel; but, unfortunately, in the gale that raged during the previous night, she had drifted from her moorings, and had thus become useless, not daring to show her lights; the consequence was, that all these ill-fated vessels ran on to the Sunk sand in a fearful sea; one of them, a schooner, went to pieces in a few minutes, and all hands perished; a similar fate attended all on board of the "Mary," except the Captain, who swam to one of the other vessels, the crew of which was picked up the next morning by some fishing vessels from the rigging, where the men had remained all night. The whole of the vessels were completely wrecked.

those periods between 12 and 1 o'clock : the rise of neap tides is 9 feet. The set of the flood tide, to the south of the sand, is from E.N.E. to W.S.W., and of ebb tides west to east. At Sheerness, which is 20 miles higher up the river, the rise of the spring tides is 17 feet 6 inches, and of neap tides 11 feet ; there is, therefore, a difference of from 2 feet to 3 feet in the rise of tide between the two places.

Soon after this preliminary survey, Mr. Mitchell, the inventor of the screw moorings, made an application to the Corporation of the Trinity House, that in the erection of the proposed lighthouse on the Maplin Sand, his screws might be used for the foundations ; suggesting that the screws should offer considerable bearing-surface, and be fixed upon the ends of wrought-iron piles, which would support the superstructure. This suggestion was favourably received, and in June, 1838, Mr. Mitchell received instructions to supply the screw piles, and to consult with Mr. Walker as to future measures.

On the 27th August, Mr. Mitchell and his son proceeded to the sand with the piles, which were manufactured of the best Staffordshire iron, 26 feet in length, and 5 inches in diameter ; each pile had near its lower end a cast-iron screw, 4 feet in diameter, firmly keyed upon the pile, round which the screw performed one revolution and a quarter ; beneath the screws the piles were finished with a large drill, or opening bit. The screws were manufactured at Messrs. Rennie's works, Holland-street, Blackfriars.

One pile was placed at each point of an octagon, with one in the centre, and they were screwed down into the sand in the following manner:—A raft, about 30 feet square, had been previously prepared, with a longitudinal opening from one side to the centre, for the admission of the pile ; this was towed over the spot where a pile was to be screwed down, and was held in its proper position by means of warps, the pile being pitched upright, and projecting through the opening left for that purpose ; a capstan head was then keyed on to the pile at the proper level, the bars were introduced, and by manual labour the piles were screwed down, the capstan-head being shifted up as the piles descended.

The first pile was screwed down on the 28th August, and all the nine piles were finished on the 5th September, the average work being one pile per day.

The labour required for screwing the piles down varied so much, that Mr. Mitchell appeared to think the ground was rather unequal ; but, for the most part, the sand appeared to be clean and firm for about the first 8 feet, and then became looser for about 3 feet,

the rest being generally uniform; and Mr. Mitchell believed it was slightly mixed with an argillaceous earth, particularly for about 2 feet towards the greatest depth.

The piles were screwed down 21 feet below low water (Fig. 1, Plate 6), their tops being 5 feet above that level, and from 4 feet to 4 feet 4 inches above the sand. In a few tides the sand was found to be considerably lower at the S.E., being 6 feet below the pile heads, whilst at the northward it had not undergone any change. Whether this deepening arose from the projection of the piles alone is doubtful, as the sand appeared to have decreased at the margin uniformly to the east and west. Still the obstruction of these piles to the current of the stream, though small, appeared to have had some influence; a slight hollow was worn around each pile, similar to what takes place on the sea-shore, around stones lying on the sand.

Early in January, 1839, the sand was found to be 4 inches lower, on an average, than in September of the previous year, being curtailed to the east of the piles, and extended to the west. In April it was, on an average, 7 feet 5 inches below the tops of the piles; being a total decrease of 3 feet in height, from the time of their being screwed down.

As the sand shifted so much, it was thought advisable to adopt some precautionary measures, to secure a foundation for the building. A raft, or grating, of timber was accordingly formed, (Fig. 2, Plate 6,) and early in June it was towed down and moored off the sand. The levels of the sand had been observed early in the month, and were found about the same as in the previous April, and they were again tried on the 24th June, before sinking the raft, when the sand was found more level and at about the same height as when the last observation was made. The timbers of the raft were so disposed as to admit the piles freely, and a curb extended all round, for retaining the stones intended to be placed upon it; the surface was covered with bavens, or faggots of small wood, filling the spaces level with the tops of the upper half timbers, and were fixed by means of ropes, interlaced with them and nailed to the timbers. The raft, in this state, was towed over the piles, from the tops of which leading ropes had previously been brought through the corresponding openings between the timbers: this precaution was necessary from the inequality of the sides of the octagon. One hundred and twenty tons of rough Kentish stone, were then thrown upon the raft, covering it to an average depth of 15 inches, causing it to sink with about two-thirds of this weight, and to ground just before low water.

From the sand having decreased so much previously, particular care was taken to obtain the levels of the raft so as to ascertain in future the amount of settlement, and on the 1st July following, it was found to have settled on an average about 8 inches: it had gone down to the N.E. about 20 inches, and at the S.W. it had risen 4 inches. As it had settled so very unequally, it was determined to endeavour to counteract this, by placing some additional stone on the highest part; sixty tons were accordingly added on the 30th July, the greater portion being placed to the W. and S.W. In the course of the next day there was a fresh gale from W.S.W. and the raft, from the additional weight, sunk 1 foot 7 inches, and became more level; in August following it was again tried, and found to be in about the same condition.

In November, from the gales that prevailed, the raft was found to be 14 inches lower and more out of level, being 2 feet lower on the north than on the south side. In April, 1840, it had again settled 15 inches; but was more horizontal, being but 10 inches out of level, and the curb to the northward was covered with sand; early in July it was found to remain the same as to level, and the sand had accumulated more around it.

Early in the summer of 1840, orders were given to proceed with the work for the superstructure, and the tenders of Messrs. Gordon and Co., of Deptford, for the iron work, and of Messrs. Gates and Horne, of Poplar, for the carpenter's and joiner's work, of the proposed construction, having been accepted, both portions of the work were properly fitted and erected at the establishments of the Contractors, before they were sent down to the sand.

The iron work was taken down to the sand on the 19th August; the cast-iron bases were first shipped over the pile heads, and dropped upon the stonework of the raft, and solidly bedded: on the tops of these bases were placed concentric rings, forming washers, fitting loosely over the piles, and of various thicknesses, so as to render the bases of one uniform level at the top.

The columns were all put up, and the wrought-iron work was fitted early in September; a stage was then erected on the upper horizontal braces, to facilitate the erection of the timber framing, which was so far advanced by the middle of October, that the lantern was sent down, and the whole was completed early in the year 1841.

The lighting apparatus and lantern were manufactured by Messrs. Wilkins and Son, of Long Acre: and the light was first exhibited on the night of the 10th February, 1841. It is a French dioptric light of the second order; its centre is 45 feet above the mean

level of the sea, and at this elevation it may be seen from the deck of a ship for a distance of nearly ten miles. (Fig. 3, Plate 6.)

A bell is fitted on the gallery, to be sounded at regular intervals in dark and foggy nights, by means of clock-work within the lantern base.

A space of 2 inches was left between the tops of the bases and the lower ends of the columns; so that, in the event of the piles sinking with the weight of the building, after settling 2 inches, the structure would rest upon the bases, and through them on the large bearing surface of the raft, amounting to about 1700 square feet, being fifteen times the area of the nine screws, the bearing of which is 113 superficial feet, being 12.56 feet to each pile.

As the water ebbs at times below the tops of the bases, the piles were exposed for a length of 2 inches, giving the bases a somewhat weak and unsightly appearance. To obviate this, nine covering irons were cast, the exterior ones being 2 feet in length, and the centre one 3 feet; they were each formed of two semicircular pieces, fitting together with lapped joints, and screwed with counter-sunk screws, having each a projecting flanch inside to support them on the bases. The upper part of the bases and the lower ends of the columns, were thus enclosed, and at low water these covering irons had the appearance of bases to the columns, and they fitted loosely, so that, in the event of any settlement, they would offer no obstruction to the columns. A mark was made on the outside of each column, 12 inches above these bases, to ascertain if any subsidence did occur. This, of course, could only be observed to the extent of 2 inches, when, as before described, the structure would bear upon the raft. If, however, any further subsidence should take place, it can be ascertained by means of other marks that have been made for that purpose; but up to the present time not the slightest settlement of the building has taken place.*

The total weight of the structure is about 72 tons, being a weight of 8 tons per pile, or 12½ cwt. per superficial foot of bearing surface of the screws, at the ends of the piles.

The paper is illustrated by three drawings, Nos. 3375 to 3377, from which Plate 6 is compiled.

* No subsidence of the building has been observed up to the middle of the year 1848.

MAPLIN SAND LIGHTHOUSE

FOUNDED ON MITCHELL'S SCREW PILES.

SECTION.
Fig. 1.

Fig. 2

PLAN OF RAFT.

ELEVATION.
Fig. 3.

Scale of Feet.

Plate presented by the Screw Pile Company.

Day & Son Lith. To the Queen.

J. B. Redman, Del.

APPENDIX.

DESCRIPTION OF THE CONSTRUCTION.

The iron work supporting the superstructure, and placed immediately upon the screw piles, consists of nine hollow cast iron columns, or pipes, the exterior ones curved at the top to a radius of 21 feet towards the centre, with projections to support the wrought-iron collars to which the ties are bolted. The columns, at 4 feet from the bottom, have a stop cast in them to rest upon the piles, and are finished at the top with a socket to receive the timber columns of the superstructure; the centre column is shipped 2 feet over the centre pile; the columns at each end are strengthened by wrought-iron hoops, put on hot, and suddenly cooled. The ties are of wrought-iron, connected to the outer columns by collars with arms, embracing the ends of the ties which are flattened out; the ties at the centre of the building are finished with projections, forming part of a circular collar, which encloses the centre column; the projecting flanges are bolted together; the braces are arranged so that there should be a tier of horizontal ties between the outer columns, about 10 inches above the pile heads, and similar ones radiating from the centre column to the north, south, east, and west columns. Four sloping diagonal ties connect the centre column to the N.E., N.W., S.E., and S.W. columns, near the level of the upper horizontal ties, and are fixed in the same way as the lower ones. These horizontal ties are attached immediately below the sockets in which the timbers rest, at which level, sloping ties connect each of the exterior columns to the upper part of the centre one, which stands 7 feet above the rest.

The columns of the timber superstructure are stepped into the iron columns, and are well braced together; the tiers of horizontal bracing form the supports for the floors and gallery. The braces are partly supported by oak cleats, screwed to the uprights, to which the half timbers are bolted, and the whole timbers abut against them, being partly let in and secured by wrought-iron gibs, and keys, and cleats, and attached at the centre by wrought-iron knees and bolts.

The superstructure is further strengthened by a raking brace being placed at every external column, at the level of the lower floor, and abutting against the centre column, into which four of them are tenoned, and are secured by wrought-iron knees and bolts, the upper ends being bolted to the half timber braces of the lower floor; the lower ends of the remaining raking braces are stepped upon the others, and at the outer ends are fastened to them in a similar manner. Between each of these braces quarters are fixed, and the whole is boarded inside and out, forming the store for coals, water, &c. Both the tiers of horizontal bracing are bounded by curbs, which fit in between the main pillars, and are fastened by wrought-iron knees, and through bolts; the upper curb is level with the tops of the pillars. The joists of both floors are caulked on to the horizontal bracing, those of the lower floor being tenoned into the curb.

The lantern base is supported upon a curb, in pieces 8 feet long, the ends of which are half-lapped, bedded on, and bolted to the upper horizontal braces. The basement, or plinth, consists of sixteen sides, the angles being formed by two

quarters, tenoned below into the curb, and at the top into the cill of the lantern, which is of oak, weathered and throated, and the joints dove-tailed and half-lapped: the quarters are well braced, and the wrought-iron through bolts, which hold down the lantern, pass between the quarters at each angle, and are screwed up underneath the lower curb of the basement. The plinth, or basement, is covered with two casings of boarding, an inch thick, the inner casing being placed horizontally, and the outer vertically. The joists of the lantern floor are laid, like those of the lower floor, upon the horizontal bracing and the lower curb of the lantern base; the joists of the lantern gallery rest upon the curb of the lantern plinth and upon the upper outer curb, radiating nearly from the centre, there being one at each angle, and the whole is covered with boarding, which receives the lead flat.

The sides of the dwelling are covered both on the outside and the inside with boarding; the joints are ploughed and tongued, and each board is strongly nailed to the three tiers of quarters; the outside boarding at the bottom, is rebated into an external moulded curb, which is fixed to the outside of the principal curb, and the principal posts, or columns, are rebated, for a width of 2 inches at the angles, to receive the boarding; and the faces of the columns are covered with pilasters, or covering boards, rounded on the edges, and reaching about 3 feet 6 inches below the lower curb, being terminated at the top by brackets, against which the cornice abuts. The gallery and cover boards of the cornice are covered with lead.

The window-frames are supported in a frame-work, the posts of which receive the quarters of the sides; the window cills are of oak, weathered, and throated in front; the sashes are single, and, like the shutters, slide up and down inside the outer boarding.

The door is on the N.W. side, and the quarters of the side are tenoned into the posts, the jamb linings being nailed to these posts; the cill is of oak, throated and weathered, and the head is finished like the jambs. The two leaves of the folding-doors are framed and battened with deal 2 inches thick, and when shut they are flush and fair with the outside of the dwelling.

The interior of the dwelling is arranged and partitioned off, so that the sleeping berths are kept distinct from the living room, by having small state rooms and doors in front. The store has bins for tow, provisions, &c.; in it are kept the oil cisterns, and the stairs up to the lantern are enclosed by partitions. The communication with the lower store, in which coals are kept, is by a trap close to the entrance doorway; the water-closet and water-tanks are likewise placed in this lower store.

Outside of the entrance-door is a landing, or platform, from which the ladder descends to the level of the top of the N.W. iron column, where it is supported by a cast-iron bracket; on the surface of this ladder, the second length slides upon rollers travelling on wrought-iron plates. This portion of the ladder reaches to near low water, and is raised by means of a rope and barrel, worked by a ratchet-wheel and lever, the rope having balance weights at the other end, which slide up and down against the face of the pillar. There is likewise a break for lowering it: by this contrivance the building can be reached at any time of the tide, as the lower end of the ladder, when let down, reaches sufficiently near to the surface of the water at low tide to enable persons to land on it.

PRINCIPAL DIMENSIONS, SCANTLINGS, &c.

Iron Work.

Screws	4 feet diameter
Piles	26 feet long, 5 in. "
Cast-iron columns (external)	18 " 11 in. "
and $1\frac{1}{2}$ inch thick.	
Lower wrought-iron ties	$2\frac{1}{2}$ in. "
Upper ditto	2 in. "
Wrought-iron screw-bolts to couplings of ties	$\frac{3}{4}$ in. "

Timber Work.

External columns, 30 feet long, 12 inches square at the bottom and $10\frac{1}{2}$ inches at top.	Inches.	Inches.
Half timber horizontal braces	12	$4\frac{1}{2}$
Upper whole ditto	10	10
Lower ditto	11	10
Raking braces	10	10

Joiners' Work.

Lantern curb	12	9
Oak cill to ditto	12	6
Oak window cills	12	9
Oak door cill	12	9
Door posts	6	5
Jamb linings to door	$2\frac{1}{4}$	thick.
Outside boarding to sides of dwelling	2	"
Inside ditto	$1\frac{1}{2}$	"
Pilaster boards	2	"
Boarding to lower store	2	"
Ditto to lead flat	2	"

Mr. WILKINS stated, in answer to questions from the President, that he had seen the Edystone and the Maplin Sand Lighthouses during severe gales of wind; that, as might be conceived from the nature of the construction, the latter building was more affected than the former by the striking of heavy seas: the motion appeared to be more like torsion than simple vibration, which he attributed to the waves striking the ladder and its projecting stage, and thus tending to twist the upper part. Still the motion was not such as would cause injury to the building.

Mr. WALKER, President, pointed out two diagonal braces, extending downward from the end of the ladder stage to the piles on either side; these had been introduced in order to counteract the twisting described by Mr. Wilkins. In constructions of this nature, it was of importance to oppose as little resistance as possible to the waves, especially in the upper part of the building; a system of