

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Military Works.

READ—the following papers :—

MEMORANDUM.

Bellary Arsenal New Workshops.

Work ordered in G.O., M.D. No. 3095, dated 9th May 1887. Materials ordered to be collected in anticipation of sanction to estimate by the Superintending Engineer, Mr. Peters, in his No. 1116, dated 14th September 1887, giving at the same time height of walls and basement, but saying nothing about foundations. Materials and work to the value of Rs. 15,558-4-7 were collected and done to end of March 1888 though only Rs. 6,887-9-4 actually paid. G.O., P.W.D. No. 1199 W., dated 23rd April 1888, sanctioned them.

2. The estimate was approved by Inspector-General of Ordnance and Director-General of Ordnance and forwarded to Government by the Inspector-General with his No. 64 G., dated 18th July 1888, and it was finally sanctioned on 17th August 1888, No. 2527 W., Public Works, for Rs. 45,500, the only remark of the Chief Engineer being that ramps should be provided instead of steps.

3. The estimate was prepared by the Executive Engineer, Mr. Garrett, in consultation with the Ordnance officer and submitted by him to the Superintending Engineer (Colonel Smalley) on the 29th November 1887, by whom it was countersigned on the 21st January 1888 and forwarded to the Inspector-General of Ordnance. It must be here remarked that the report attached to the estimate was very meagre.

4. The site was selected by a committee on the 7th October 1889, of which the Executive Engineer was a member. Their opinion was that "the only ground within the arsenal suitable for the erection of a workshop is a site in line with the present harness store-room," and this is the site on which the workshop has been built, except that, at the instance of Ordnance officer approved by the President of the Committee, the site was moved nearer the harness room than originally intended.

5. Work was begun in February 1888. Three trial pits were sunk 12 feet deep in the centre and at each end of the site selected. Nothing but made-earth was found to that depth except stones apparently from some old foundations. The earth stood perpendicularly in the pits and appeared to be thoroughly consolidated though not the natural soil. There were existing buildings on either side of the site selected and close to it. There was the rampart wall of the fort running nearly parallel to the face of the site selected which was looked upon as sufficient to retain the soil behind it in position. Moreover, the Engineer's offices had been constructed lately under similar conditions not far off.

6. The plan and estimate allowed 6 feet depth of foundation, viz., 4 feet masonry in steps and 2 feet of concrete below 6 feet wide at bottom, and the work was carried out accordingly except in the case of the chimney where Mr. Clift put in 4 feet of gravel well rammed below the concrete and which has stood perfectly well though 40 feet high.

7. Before the end of the rains of 1888 the superstructure had been raised about 6 feet high all round and no signs of settlement were apparent. The work has been

built slowly and deliberately throughout. Nothing was noticed in the shape of cracks or settlement till the 9th October 1889, after which they increased to the present state by the 22nd idem; they have not increased since that date.

8. The rainfall at Bellary in 1889 has been quite abnormal and concentrated in the months of September and October, most heavy and continuous from 1st to 21st October. The north-east monsoon succeeding the south-west without a break.

9. The harness store-room in line with the new workshop, a building 50 years old or more, has been badly cracked; a bastion of the fort wall in the arsenal enclosure immediately below the workshop has collapsed (which no doubt has added to the disintegration of the soil above); and in five other places has the fort wall fallen down in consequence of the rain.

10. The execution of the work has been thoroughly good throughout; the initial mistake is alone to blame, insufficient foundations, and I can only bitterly regret that I was induced to pass them against my better judgment. Great trouble has been taken with the roof, with the chimney, and with fixing the boiler and pipes in position especially. The expenditure up to date including liabilities not settled is Rs. 35,642-6-0 against the estimate Rs. 45,500. The work is therefore not only good, but has been carried out economically. It is very nearly completed; all that remains to do is to roof in with Mangalore tiles, and finish up generally before fixing machinery. It seems a great pity to condemn the building altogether if it can possibly be avoided.

11. I suppose that underpinning on a large scale all round on both sides of the walls inside and outside is all that can be attempted to make the building secure. The machinery must have independent supports and not be in contact with the present walls. Plinth protection with drains all round must be given. The drainage under the foundations must be cut off above the site. The fort rampart should be rebuilt *pukka* to serve as a real retaining wall to the soil behind it. The cross walls inside the building might be removed perhaps either partially or wholly. Iron pillars might be introduced under the trusses. Bonding stones and iron or copper joggles would I suppose be necessary to bind the cracks in the walls. I think now that what ought to have been done at first (supposing there was no appeal against the site) was to have insisted upon an underground basement forming cellars for stores, &c., connected with the surface by stairs and ramps and lighted and ventilated by openings into an area all round the building. I am not prepared to say whether it would be practicable now to effect this by tunnelling underneath the present workshop walls. If it were considered practicable, a fine large space could be made available for stores and thereby probably avoid requisitions for such space in future and the building above would be made secure.

12. The floor of the present building would have to be supported on girders and presumably boarded throughout.

(Signed) H. SMALLEY, Colonel, R.E.,
Superintending Engineer, III Circle.

ENCLOSURES.

From A. S. RUSSELL, Esq., Executive Engineer, Bellary Division, to the Superintending Engineer, III Circle, dated Bellary, 21st October 1889, No. 2600.

I have the honor to report that the walls of the new Workshop, Bellary Arsenal, have lately cracked to such a degree that it becomes a question for consideration whether the work now going on of roofing in the building shall be allowed to continue until the steps necessary to prevent further cracking of the walls have been taken.

2. The original estimate for the building amounted to Rs. 45,500 and was sanctioned in G.O., No. 2527 W., dated 17th August 1888. The accompanying tracing shows the section of the walls and foundations. The building is founded on made-earth. Neither the report nor plan, which is forwarded herewith, shows that three trial pits were sunk to a depth of 12 feet in made-earth, and the maistry in charge of the work reports that, when the estimate was under preparation, borings to a depth of 15 feet were taken without anything but silt being passed

through. The site is in fact nothing but a mound of made-earth, bordering the wall and bastions of the fort, while immediately below the fort wall runs the deep moat (*vide* accompanying sketch).

3. I only took charge of the Bellary division on 15th instant. When going over this building with Mr. Clift, the former Executive Engineer, slight cracks in both the cross walls and main walls were pointed out to me. These cracks had only appeared about 6th instant, and both Mr. Clift and I agreed that these were undoubtedly due to inadequate foundations, and that the only remedy was underpinning the cracked portions of the walls with concrete. Copy of my inspection notes made at the time are sent up for information. I observe from the office records that Mr. Clift reported the occurrence of these cracks in this office letter No. 2533, dated 15th instant.

4. From 15th to 19th instant I was away from head-quarters on tour. To-day I again inspected the building, and found that, while the old cracks had opened out to a great extent, numerous new cracks had appeared both in the main and cross walls. These cracks are of the most serious character, some of them gaping to over one inch in width. I also noticed that outside the building a large crack in the ground was visible, and that the continuation of this crack ran right down the centre line of the new workshop, while radiating from this crack in the ground short transverse tracks were here and there to be seen. Close to the new workshop is the saddlery and harness room—a building said to have been constructed about the year 1815. I traced the cracks in the ground right along one side of this building, the verandah pillars of which had cracked and had evidently settled some two or three inches. Cracks in the wall of this building were also visible. Following up the cracks in the ground I traced them to the fort wall which had, in some portions, fallen down, while one of the bastions had also fallen and another appeared to be in a very shaky condition. These damages are all reported to have occurred about the same time, viz., after the very heavy and continuous rains of last week. On the whole, it is plain to me that the mound of the made-earth on which all these structures stand has parted in the middle, one portion of it slipping down towards the deep depression of the moat.

5. As regards the causes of the damages, it is to be noticed that, in addition to the inadequate foundations given to the new workshops, it is probable that the made-earth on which the building stands is composed of various soils, and that, so far as can at present be seen, the earth near the surface is a loose porous kind of silt, which is liable to crack after heavy rain, and through which rain-water would percolate, and would ultimately drain into the moat below. The slight cracks first seen in the workshop walls were doubtless due to weak foundations and inequality of settlement, while the damages afterwards done simultaneously both to the new workshop and to structures which had stood unharmed for many years, were certainly due to the cracking of the made-earth on which the buildings are founded.

6. The workshop is now in an advanced stage of completion. The iron trusses of the roof have been put into position, and over them a portion of the building has been roofed in with Mangalore tiles. The work of tiling the remaining portion of the roof is now in progress, and I request orders whether I am to go on with this work or wait until it has been decided what is to be done as regards the foundations of the building. I may here notice that the expenditure up to date is very inadequate, the grant for the year being Rs. 15,992 and the expenditure to date being only Rs. 4,166.

7. Until I have exact information regarding the nature of the made-earth on which the building is erected, and regarding the depth* at which natural ground is found, I can make no specific proposals regarding what should be done. I have not, however, delayed my report on this account, as, should the cracks in the walls go on, the safety of the building may be endangered. The subject is, I think, of sufficient importance to make personal inspection by the Chief Engineer advisable. My own opinion is that, that unless the foundations are carried down to hard ground, the walls will never be safe when it is considered that they will ultimately be subjected to the continual jarring of machinery, and that the cracking of the made-earth may again occur at any time after heavy rain. The expense of carrying down foundations to hard ground will doubtless be very great, as they will certainly have to be sunk a great depth, and the work will be of so tedious and difficult a character that it may be a matter for consideration whether, in the end, it will not be advisable to abandon the present building and erect a new one on a better site. In another week the result of the borings will be known, and some definite decision can then be arrived at.

EXTRACT from Inspection Notes of A. S. RUSSELL, Esq., Executive Engineer, Bellary Division, for the month of October 1889.

New Workshop, Bellary Arsenal.

This massive building is everywhere founded on made-earth, and the maistry in charge reports that trial pits at each corner of it were carried down 15 feet without solid ground being reached. Building on such ground is a risky experiment, and has resulted in some serious cracks

appearing in the walls. These cracks are undoubtedly due to defective foundations. They will probably open out still more as the rains go on. Nothing can now be done till the rains are over, but the cracks should be carefully watched, and, to enable it to be ascertained whether they are extending, a piece of paper about 6 inch square should be tightly stretched, and pasted over each of the more important cracks, with the date it is pasted on written on it. As the nature of the sub-soil has never yet been properly ascertained and recorded, borings should now be taken until solid ground is reached and the result of the borings carefully noted and reported.

2. The only remedy that will be effective will be underpinning with concrete, and thereby giving to the walls a deeper and wider base than they now have. The work will have to be carefully done by small portions at a time. The design will be made by the Executive Engineer, when the result of the borings now ordered has been ascertained. Arrangements should at once be made by Sergeant Temple to do this, and the result should be reported in due course.

9th October 1889.

(Signed) A. S. RUSSELL,
Executive Engineer.

Note by the Acting Chief Engineer, Public Works Department, General Buildings and Roads Branch.

Arsenal Workshops, Bellary.

The building was inspected by me in company with the Superintending Engineer and the Sub-Engineer, Sergeant Temple, who was in immediate charge of the work. Upon a critical examination of the building itself and its surroundings, I came to the conclusion that the cracks were due to an actual creeping of the made-soil in which the foundations were laid towards the hollow ground that intervened between it and the ramparts of the fort. The quality of the masonry itself was good, although the side joints of the stones composing it were not as fine as they should have been, but the failure could not be attributed to this defect. I noted that the foundation trench had not been filled in carefully round the work when it was completed, and the heavy rain had caused serious depressions along the line of the walls. If the plinth protection in the shape of a gravelled platform had, as provided for in the estimate, been laid down as soon as the trench had been filled in, and care taken to carry away the water draining off the ground above the work instead of allowing it to flow down to and into the foundations, it is probable that no damage to the building would have accrued. The structure is at present so shaken that it cannot possibly be used as workshops, and the only thing that can be done is to brace the walls together by iron tie rods and use the building as a store. It would be necessary that a committee should be convened to decide upon the ultimate use the building is to be put to, as well as for the selection of a site for a new building which is urgently required.

MADRAS, (Signed) R. R. E. DRAKE-BROCKMAN, Lt.-Col., R.E.,
15th November 1889. Ag. Chief Engineer, P.W.D., General Buildings and Roads Branch.

ORDER—dated 4th December 1889, No. 3442 W., Public Works.

His Excellency the Governor in Council considers that the failure of the building constructed for the Workshops of the Bellary Arsenal is most regrettable and unsatisfactory. The Chief Engineer being of opinion that the failure was caused by the omission to lay down the gravel protection provided for in the estimate, the Executive Engineer in charge of the work, Mr. H. W. Clift, will be called on, through the Railway Branch, to explain why he did not execute this item.

2. In accordance with the recommendation of the Chief Engineer, the Government resolves to appoint a committee, composed as under, to consider and report how the building can be utilised, and to select a site for a new building for the workshops:—

The Superintending Engineer, III Circle.

The Executive Engineer, Bellary Division.

An officer of the Ordnance Department to be nominated in the Military Department.

3. It will be considered in the Military Department whether the Officer Commanding Bellary should be added to the committee, as it is possible that the building may be found of use for other military purposes than those of the Ordnance Department.

4. Meanwhile the Superintending Engineer will take steps to make the building secure, as suggested by the Chief Engineer.

(True Extract.)

W. B. Boddie

Captain, R.E.,
Under-Secy. to Govt., P.W.D.

To the Superintending Engineer, III Circle.
" Military Department.
" Public Works Department (Railway Branch).

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BUILDINGS AND ROADS.
MILITARY WORKS.

Gobt. of {1889} Madras.

PUBLIC WORKS.

Dated December, 4th.

Recd.

Encl.

G.O., 4th Dec. 1889, No. 3442 W.

DECEMBER.

Building constructed for the
Arsenal Workshops, Bellary

Passing orders on reports regarding the
failure of the —.

B. A. 7 R 97. Jan'y 1890.

Hel
21 Dec 1889

Communicated to
the Consulting Engineer
for Railways who will
call upon Mr. Blift for
the required explanation

C.S.

19.12.89

R.

B. A. 7 R 97. Jan'y 1890.

To
The Consulting Engineer

Wf
Sf

27/11

M. 20-12-89 R 21-12-89