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# MADRAS RECORD OFFICE

Government of Madras

*Public Works*

DEPARTMENT

|          |        |       |
|----------|--------|-------|
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| Dated    | 21. 1. | 195   |
|          |        | 1875  |

*Original*

Not to be folded or roughly handled

*Proceedings of the Madras Government, Public Works Department,  
21st January 1875.*

Read the following papers:—

No. 358. From Major J. BEATTY, R.E., District Engineer, Godavari, to Lieutenant-Colonel J. MULLINS, R.E., Chief Engineer for Irrigation, dated Dowlaishwaram, 10th November 1874, No. 2,527.

With reference to paragraph 3 of your Note, No. 600 of 20th August, printed with G. O., No. 2,606 of 14th September 1874, I have the honor to inform you that having recovered specimens of the limestones which were experimented upon by Mr. Dejoux, I find the classification to be as follows:—

Crystalline, Nos. 2, 7, 8, 15.  
Semi-crystalline, „ 1, 3, 10, 11, 12.  
Non-crystalline, „ 4, 5, 6, 9, 13, 14.

2. All these samples of limestone were obtained from the same quarry, at Chagallu, about ten miles from Chettipeta, in the Western Delta, which now supplies lime to all the works of that delta.

3. And the great value of Mr. Dejoux's experiments appears to me to consist in this, that they seem to demonstrate that any attempt to obtain improved results by a selection of stones according to their color or appearance must prove futile.

4. For instance, no two stones could be more unlike than Nos. 8 and 14. No. 8 is the darkest of all in color, and the most highly crystalline, while No. 14 is the whitest and most clay-like, in fact it specially resembles a bit of petrimed pipe-clay; and yet they are found to contain nearly the same proportion of oxide of iron, carbonate of lime, etc.

5. However, the experiments now in progress will probably show more conclusively than anything else whether there is any advantage in making a selection of stones out of those furnished by the same quarry.

6. The previous experiments having shown that the mechanical mixture of burnt limestone with burnt clay in suitable proportions is the most cheap and convenient method of forming a cement for general use, a further double set of experiments is now being made with the view of ascertaining conclusively whether any advantage results from a selection of stones. The one series will be made with equal proportions of the three classes of stones previously employed, viz.,

*Vide* Table of results accompanying Captain Brockman's report. crystalline, semi-crystalline, and non-crystalline; and the other with stones taken indiscriminately from the quarry.

7. In addition to these experiments another set has been undertaken to ascertain the result of air-drying the bricks for six hours before immersion, and keeping them in the water until they are sufficiently firm to bear the pressure of one pound applied on top of an iron pointed pin. It has been found that immersion for eighteen hours only is insufficient, as the bricks will not then stand any

it; it has therefore been decided to keep them immersed until they can resist pressure applied to the pointed pin.

Information is also being collected regarding the cost of preparing the lime and clay, and mixing them to form the cement.

9. These will probably all be completed and reported on in about six weeks, the weather having been, and still being, the chief cause of delay.

10. I find that I was in error in stating in my former letter that "where the columns are left blank it is to be understood that the bricks bore no strain whatever." I should have observed that this remark only applied to Tables I., II. and III., and that the meaning of the blank spaces in Table IV. was that that series of experiments had not been concluded. Captain Brockman has now furnished me with a complete Table No. IV., which is herewith sent.

11. I should also have explained that the bricks were immersed almost immediately after being made, and that the number of each description experimented upon, from which the average given in the tables was deduced, was four.

12. The variations of strength noticed in the tables is doubtless due, as suggested by Captain Brockman, to the small size of the bricks, and the impossibility of ensuring perfect solidity and freedom from flaws and cracks, which must very sensibly affect their strength.

13. All that is now wanted towards carrying out the use of a cement composed of burnt lime and soorkee more generally on our works, and commencing the preparation of concrete blocks on a large scale, is the purchase of Soorkee mills.\* I propose† to purchase two in the first instance, one for No. I. Range and one for No. III., and I request that funds may be allotted under "Tools and Plant." The cost of each mill, including carriage from Calcutta, will be about 250 Rupees.

From Captain R. R. E. BROCKMAN, R.E., Executive Engineer in charge No. 1 or Eastern Delta Range, Godavery District, to Major J. BEATTY, R.E., District Engineer, Godavery District, dated Dowlaishweram, 7th November 1874, No. 368.

In acknowledging the receipt of G. O., No. 2,606, dated 14th September 1874, relative to the experiments for determining hydraulic cement now in progress, I have the honor to offer a few explanations regarding the points raised in the memorandum, No. 600, from the Chief Engineer for Irrigation, dated 20th August 1874, embodied in the above Government Order, paragraph 3. It is believed that the demarcation of the limestones into their qualities of crystalline, semi-crystalline, and non-crystalline has no connection with the quality of the limes deduced from them. No. 14, for instance, is altogether non-crystalline, and resembles compressed pipe-clay, whilst No. 8 is the most highly crystalline of the specimens Mr. Dejoux experimented upon, besides being the darkest in color. On referring to the table furnished by Mr. Dejoux, however, it will be seen that chemically treated the constituents of both these apparently contrary specimens are almost similar in quality and quantity. The limestone beds, moreover, containing these fifteen specimens intermingled in a way that would render it very expensive were one view of a peculiar quality

solely worked. Table III. of experiments upon burnt lime, mechanically mixed with soorkee in varying proportions, distinguished the limestone under the three broad heads above referred to. I have completed a similar series with lime as taken from the kilns, and hitherto ordinarily use upon the works in this delta. These results I have tabulated and forward herewith. I have instituted a third series of experiments with burnt lime and soorkee, in which the lime consists of equal parts by weight from the three descriptions of limestone separately burnt. These have not yet been completed.

2. In Table IV., which accompanied your letter No. 1,418, dated 5th August last, the blank spaces in the columns under the different series of experiments, were intended to show that the bricks, of the ages and descriptions therein noted, had not yet been broken. These, however, were tested as they arrived at maturity, and the results entered in the register kept on the works. A complete Table No. IV. is accordingly herewith sent.

Paragraph 6.—All the bricks were placed in water immediately after being made, and were exposed to the air perhaps not more than about a quarter of an hour at most. The number of each description of bricks experimented upon has been, hitherto, four.

Paragraph 7.—Now that the complete Table IV. has been furnished, the remark in the latter portion of this paragraph does not so forcibly apply. In making the bricks it is very difficult to ensure perfect solidity and to guard against the existence of any air holes and flaws in the waists of the specimens. The area of 2.25 square inches being so small air holes aggregating one-eighth or one-fourth of a square inch in area would affect the strength very materially, whereas in a larger specimen the proportion of theoretic to effective cross section area would not be so great.

Paragraph 8.—As all the bricks were put in water immediately after they were made, the results do afford "evidence of the degree in which the characteristic [of rapid setting] was exhibited," and speak greatly in favor of the hydraulic energy of the cements experimented upon. In accordance with the Chief Engineer's suggestion, however, experiments have been instituted of air drying for various lengths of time not exceeding twenty-four hours, and immersion for similar varying periods under water, and these are now in progress.

Paragraph 9.—As the experiments have hitherto been on a such a small scale, it has been impossible to ascertain the cost of burning the different descriptions of limestone so as to be of any practical use. In my opinion the mechanical mixture of burnt lime and soorkee is the one that can most easily be adopted on all hydraulic works. The soorkee can be prepared from the description of clay found to combine best with the lime. The burnt clay should be ground to a fine impalpable powder in one of Wells' Patent Portable Soorkee Mills and kept in stock for issue to the works, in the same manner as lime and sand are at present. I have the honor to request

therefore that the mill which has already\* been indented for from Calcutta may be supplied as soon as possible. There is ample room on the

Main Canal Lunka, east of the 'dry Dock, for establishing the Soorkee factory and manufacturing concrete blocks for building.

\* This is a mistake. Instructions are required against what head of account to charge the mills if purchased.—J. B.

The steam mill which has been obtained from Dumagudiem is used more for milling mortar, and is not, I consider, adapted for crushing soorkee, for which the ordinary coffee mill arrangement, improved upon in Mr. Well's machine, is more suited.

Proceedings of the Madras Government, Public Works Department  
21st January 1875.

No. III.

CEMENT EXPERIMENTS.

Burnt Limestone mixed with Burnt Clay.

| QUARRY CHANNEL CLAY. |                         |      |     | GODAVERY RIVER SILT. |                         |      |     | Remarks.                                                                                                                                                                                                                                                                           |
|----------------------|-------------------------|------|-----|----------------------|-------------------------|------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Days old.            | A.                      | B.   | C.  | Days old.            | A.                      | B.   | C.  |                                                                                                                                                                                                                                                                                    |
|                      | Indiscriminately mixed. |      |     |                      | Indiscriminately mixed. |      |     |                                                                                                                                                                                                                                                                                    |
|                      | 1 B. L. to 1 B. C.      |      |     |                      | 1 B. L. to 1 B. C.      |      |     |                                                                                                                                                                                                                                                                                    |
| 7                    | ...                     | 114½ | ... | 7                    | ...                     | 168½ | ... | The bricks were immersed in water immediately, or within a quarter of an hour after they were made.<br>Number of bricks of each kind experimented on, 4.<br>Area subjected to strain 2½ square inches (1½ × 1½).<br>A.—Crystalline.<br>B.—Semi-crystalline.<br>C.—Non-crystalline. |
| 14                   | ...                     | 208½ | ... | 14                   | ...                     | 245  | ... |                                                                                                                                                                                                                                                                                    |
| 21                   | ...                     | 252½ | ... | 21                   | ...                     | 270½ | ... |                                                                                                                                                                                                                                                                                    |
|                      |                         | 192  |     |                      |                         | 228  |     |                                                                                                                                                                                                                                                                                    |
| D.                   | 1 B. L. to 1½ B. C.     |      |     | D.                   | 1 B. L. to 1½ B. C.     |      |     |                                                                                                                                                                                                                                                                                    |
| 7                    | ...                     | 138½ | ... | 7                    | ...                     | 173½ | ... |                                                                                                                                                                                                                                                                                    |
| 14                   | ...                     | 240½ | ... | 14                   | ...                     | 266½ | ... |                                                                                                                                                                                                                                                                                    |
| 21                   | ...                     | 283½ | ... | 21                   | ...                     | 284½ | ... |                                                                                                                                                                                                                                                                                    |
|                      |                         | 221  |     |                      |                         | 241  |     |                                                                                                                                                                                                                                                                                    |
| D.                   | 1 B. L. to 1½ B. C.     |      |     | D.                   | 1 B. L. to 1½ B. C.     |      |     |                                                                                                                                                                                                                                                                                    |
| 7                    | ...                     | 159½ | ... | 7                    | ...                     | 185½ | ... |                                                                                                                                                                                                                                                                                    |
| 14                   | ...                     | 296½ | ... | 14                   | ...                     | 238½ | ... |                                                                                                                                                                                                                                                                                    |
| 21                   | ...                     | 325½ | ... | 21                   | ...                     | 270½ | ... |                                                                                                                                                                                                                                                                                    |
|                      |                         | 260  |     |                      |                         | 231  |     |                                                                                                                                                                                                                                                                                    |
| D.                   | 1 B. L. to 1½ B. C.     |      |     | D.                   | 1 B. L. to 1½ B. C.     |      |     |                                                                                                                                                                                                                                                                                    |
| 7                    | ...                     | 158  | ... | 7                    | ...                     | 165½ | ... |                                                                                                                                                                                                                                                                                    |
| 14                   | ...                     | 270½ | ... | 14                   | ...                     | 231½ | ... |                                                                                                                                                                                                                                                                                    |
| 21                   | ...                     | 310½ | ... | 21                   | ...                     | 262½ | ... |                                                                                                                                                                                                                                                                                    |
|                      |                         | 246  |     |                      |                         | 220  |     |                                                                                                                                                                                                                                                                                    |
| D.                   | 1 B. L. to 2 B. C.      |      |     | D.                   | 1 B. L. to 2 B. C.      |      |     |                                                                                                                                                                                                                                                                                    |
| 7                    | ...                     | 128  | ... | 7                    | ...                     | 198½ | ... |                                                                                                                                                                                                                                                                                    |
| 14                   | ...                     | 193  | ... | 14                   | ...                     | 284  | ... |                                                                                                                                                                                                                                                                                    |
| 21                   | ...                     | 246  | ... | 21                   | ...                     | 269  | ... |                                                                                                                                                                                                                                                                                    |
|                      |                         | 189  |     |                      |                         | 250  |     |                                                                                                                                                                                                                                                                                    |

DOWLAISHWERAM,  
7th November 1874.

(Signed) R. R. E. BROCKMAN, Captain, R.E.,  
Executive Engineer, Godavery.

Proceedings of the Madras Government, Public Works Department  
21st January 1875.

No. IV.

CEMENT EXPERIMENTS.

Burnt Limestone in powder mixed with Burnt Clay in powder and water.

| Days old.     | A.                             | B.              | C.                | Days old.     | A.                            | B.                | C.                              | Days old.     | A.                            | B.                | C.                | Remarks.                                                                                                                                                                                                                                                                                                                         |
|---------------|--------------------------------|-----------------|-------------------|---------------|-------------------------------|-------------------|---------------------------------|---------------|-------------------------------|-------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               | All lime.                      |                 |                   |               | 1 B. L.— $\frac{1}{2}$ R. C.  |                   |                                 |               | 1 B. L.— $1\frac{1}{2}$ R. C. |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
| 14<br>21      | 24<br>40                       | 13<br>18        | ...<br>...        | 7<br>14<br>21 | 165<br>192<br>227             | 106<br>156<br>191 | 99<br>163<br>206                | 7<br>14<br>21 | 155<br>231<br>247             | 227<br>287<br>303 | 164<br>246<br>287 | The bricks in all cases were immersed immediately after they were made, or say within a quarter of an hour.<br>No. of bricks of each kind experimented on 4.<br>A.—Crystalline.<br>B.—Semi-crystalline.<br>C.—Non-crystalline.<br>Area subjected to strain 2 $\frac{1}{2}$ square inches ( $1\frac{1}{2} \times 1\frac{1}{2}$ ). |
|               |                                |                 |                   |               | 194                           | 151               | 156                             |               | 211                           | 273               | 232               |                                                                                                                                                                                                                                                                                                                                  |
| D.            | Mixed lime.                    |                 |                   | D.            | 1 B. L.—1 R. C.               |                   |                                 | D.            | 1 B. L.—2 R. C.               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
| 14<br>21      | 14<br>32                       | ...<br>...      | ...<br>...        | 7<br>14<br>21 | 172<br>212<br>261             | 117<br>202<br>230 | 120 $\frac{1}{2}$<br>234<br>283 | 7<br>14<br>21 | 140<br>217<br>250             | 188<br>256<br>281 | 172<br>250<br>294 |                                                                                                                                                                                                                                                                                                                                  |
|               |                                |                 |                   |               | 215                           | 183               | 222                             |               | 202                           | 241               | 238               |                                                                                                                                                                                                                                                                                                                                  |
| D.            | 1 B. L.— $\frac{1}{2}$ R. C.   |                 |                   | D.            | 1 B. L.— $1\frac{1}{2}$ R. C. |                   |                                 |               |                               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
| 7<br>14<br>21 | 75<br>103<br>181 $\frac{1}{2}$ | 27<br>73<br>112 | 62<br>98<br>115   | 7<br>14<br>21 | 187<br>249<br>269             | 190<br>235<br>271 | 168<br>235<br>268               |               |                               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
|               | 119                            | 70              | 91                |               | 235                           | 202               | 223                             |               |                               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
| D.            | 1 B. L.— $\frac{1}{2}$ R. C.   |                 |                   | D.            | 1 B. L.— $1\frac{1}{2}$ R. C. |                   |                                 |               |                               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
| 7<br>14<br>21 | 77<br>160<br>194               | 97<br>...<br>73 | 117<br>190<br>208 | 7<br>14<br>21 | 173<br>260<br>275             | 212<br>225<br>262 | 166<br>238<br>289               |               |                               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |
|               | 143                            |                 | 171               |               | 236                           | 223               | 231                             |               |                               |                   |                   |                                                                                                                                                                                                                                                                                                                                  |

DOWLAISHWERAM,  
7th November 1874.

(Signed) R. R. E. BROCKMAN, Captain, R.E.,  
Executive Engineer.

No. 1,058-A.

No. 359.

Note by the Chief Engineer for Irrigation.

THE further information regarding cement experiments at Dowlaishweram corrects some of the deductions made from the tables before furnished, in connection with which certain essential particulars had not then been reported. All the important conditions of the experiments should invariably be noted on each table showing the results, and they have now been taken from the correspondence and inserted in the tables.

The general result so far is that, while bricks of lime only may be capable of bearing a strain of from 20 to 30 lbs., those formed of lime and clay in various proportions have a strength of from 150 to 250 lbs. on the 2 1/2 square inches of area subjected to tension. The accompanying Tables Nos. III. and IV. give particulars of experiments with unselected burnt lime mixed with burnt clay, and with burnt lime mixed with raw clay in powder and reburnt. As before concluded, the simplest plan appears to be to mix burnt lime with burnt clay, but it will depend upon cheapness of manufacture which method should be adopted, seeing that all the ways of mixing clay and lime hitherto tried have given fairly satisfactory results. To the question, therefore, of economical manufacture great attention should now be paid. From a demi-official note from Major Beatty it appears that grinding the burnt clay has cost Rupees 2-12-0 a cubic yard, or twice as much as burning it; with the Wells' patent mills, which have recently been sanctioned, no doubt this part of the process will cost very much less, and but for the fact that the experiments have been on a very small scale, and the quantity of materials used very limited, the process of breaking and grinding clay exclusively by hand would have been inappropriate.

3. Both Captain Brockman and Major Beatty attach very little importance to the selection or separation of the three marked varieties of lime which are found together in each of the two quarries from which the Eastern and Western Delta lime kilns are supplied. They point to the analogous chemical composition of the most highly crystalline and the amorphous or non-crystalline limes in the case of Nos. 8 and 14 of the specimens analysed by Mr. Dejoux; and Captain Brockman notices that it would be expensive to work only one vein when the limes are found so much mixed up together in the quarries. The reasons on which a separation was advocated, and the way in which this separation was to be effected, have however not been fully understood. The one apparent reason for separation was the probability that these stones of widely different mechanical structure required differing degrees of heat to burn them properly, that consequently to burn one thoroughly would be to overburn the other, so that first there would be a deterioration of quality in the outturn of this mixed lime; and, secondly, a waste of fuel. The time of separation, moreover, was to be not in quarrying, but when breaking up the stone at the kilns preparatory to burning, and then no addition to the cost would be involved.

4. Practical use has already been made of the artificial cement at the Chopella lock on the Bank Canal, Eastern Delta, and the results are stated to be satisfactory. There the way of using it is reported to be: first, to mix 1 lime and 2 sand together, and then to add 1 burnt clay. This is a reversal of the usual order of mixing, and a few bricks formed in each way would soon indicate whether the clay or the sand should first be mixed with the lime.

5. Information regarding the cost of preparing burnt clay powder will soon be available, and this in full detail with weights of clay and fuel used in a kiln-charge, and the cost of each item of the process will be of great and general value, as well over the country a similar use of burnt clay in all hydraulic masonry works is to be desired, and will, when the means of preparing it are available, be enforced. As yet only a very rude plan, of indifferent proportions for economizing heat and

fuel, has been used at Dowlaishwaram, and a good model adapted for use anywhere and everywhere will, it is hoped, soon be designed by Captain Brockman. Dried bricks in mud will probably be the best material to use in its construction.

CAMP, AHMUR,

15th December 1874.

(Signed) JOHN MULLINS, Lt.-Col., R.E.,

Chief Engineer for Irrigation.

No. 360.

ORDER THEREON, 21st January 1875, No. 174.

IRRIGATION, N<sup>o</sup>. 40.

THESE papers will be printed and communicated to all Superintending and District Engineers in continuation

of Proceedings Madras Government of the 14th September 1874, No. 2,606.

(True Extract.)

(Signed) G. W. WALKER, Colonel, R.E.,

Secretary to Government.

To the District Engineer, Godavery.

„ Chief Engineer for Irrigation.

To all Superintending and District Engineers.

To the Executive Engineer, Wynaad.

Exd. S. T. Austin.

Spare Copies



S 1  
 District Engineer's Office, Godavari  
 Dowlaishweram 10<sup>th</sup> November 1874

From,  
 Major J. Beatty R.E.  
 District Engineer Godavari.

To,  
 Lieutenant Colonel J. Mullins R.E.  
 Chief Engineer for Irrigation.  
 Madras.

Enclosures 3.  
 1. Report on the  
 Experiments  
 2. Tables of results  
 of experiments

Sir,  
 With reference to para 3 of your  
 Note No. 247 of 20<sup>th</sup> August, printed with G.O.  
 No. 2606 of 14<sup>th</sup> September 1874, I have the  
 honor to inform you that, having recovered  
 specimens of the lime-stones which were  
 experimented upon by Mr. Dejoua, I  
 find the classification to be as follows:-

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- Semi-crystalline, Nos 1, 3, 10, 11, 12;
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2. All these samples of lime stones  
 were obtained from the same quarry,  
 at Chagallu, about 10 miles from Chetti-  
 pett, in the Western Delta, which now  
 supplies lime to all the works of that Delta.

3. And the great value of Mr.

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Vide Table of  
results accom-  
panying Captain  
Brookman's re-  
port.

applied to the pointed pin.

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X  
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Portable Soorkhee  
mills."

X  
mills. I propose to purchase two in the first instance one for No. I Range and one for No. III, and I request that funds may be allotted under "Tools and Plant." 2139 of 6<sup>th</sup> ultims. The cost of each mill, including carriage from Calcutta, will be about 250 Rupees.

X  
Transferred to  
Junk with accom-  
panying draft order.  
J. M. H.

I have the honor to be,  
Sir,

Your Most obedient Servt.  
J. Beatty. Major R.E.  
District Engineer Godavery.



Dowlaisweram,  
Executive Engineer's Office  
7<sup>th</sup> November 1874.

No. 368.

From,  
Captain R. R. E. Brockman R.E.  
Executive Engineer in charge  
No. 1 or E. D. Range Godavery.

To,  
Major J. Beatty R.E.  
District Engineer Goddy Dt.  
Dowlaisweram.

Sir,  
In acknowledging the receipt of  
G. O. No. 2606 dated 14<sup>th</sup> September 1874 re-  
-lative to the experiments for determining  
hydraulic cement now in progress, I  
have the honor to offer a few explana-  
-tions regarding the points raised in the  
Memo No. 600 from the Chief Engineer  
for Irrigation dated 20<sup>th</sup> August 1874, em-  
-bodied in the above G. O. Para 3. It is  
believed that the demarcation of the  
lime stones into their qualities of Crys-  
-talline, Semi Crystalline, and non-Crys-

Local No. 2120  
The District Engineer  
Godavery.

To, The Chief Engineer  
for Irrigation

Dated 10<sup>th</sup> Nov 1874  
Recd 16<sup>th</sup>

No. 2527

Enclosure 3  
Reporting further

on the subject of con-  
-crete experiments with

reference to G. O. No. 2606

of 14<sup>th</sup> September 1874

O. R. 8093/74  
11/11

No. 3587

crystalline has no connexion with the quality of the limes deduced from them. No. 14, for instance, is altogether non-crystalline, and resembles compressed pipe-clay; whilst No. 8 is the most highly crystalline of the specimens Mr. Dejoux experimented upon, besides being the darkest in colour. On referring to the Table furnished by Mr. Dejoux, however, it will be seen that chemically treated, the constituents of both these apparently contrary specimens, are almost similar in quality and quantity. The limestone beds moreover containing these 15 specimens intermingle in a way that would render it very expensive, were one vein of a peculiar quality solely worked. Table III. of experiments upon burnt lime mechanically mixed with loorkhee in varying proportions, distinguished the limestone under the three broad heads above referred to. I have completed a similar series with lime as taken from the Kilns and hitherto ordinarily in use upon the works in this Delta. These results I have tabulated

10  
tabulated and forward herewith. I have instituted a third series of experiments with burnt lime & loorkhee in which the lime consists of equal parts by weight from the three descriptions of lime stone separately burnt. These have not yet been completed. In Table IV which accompanied your letter No. 14, 18 dated 5<sup>th</sup> August last the blank spaces in the columns under the different series of experiments were intended to show that the bricks, of the ages and descriptions therein noted, had not yet been broken. These, however, were tested as they arrived at maturity, and the results entered in the Register kept on the works. A complete table No. IV is accordingly herewith sent

Para 6. All the bricks were placed in water immediately after being made, and were exposed to the air perhaps not more than about a quarter of an hour at most. The number of each description of bricks experimented upon has been, hitherto, four.

Para 7. Now that the complete Table IV has

has been furnished, the remark in the latter portion of this paragraph does not so forcibly apply. In making the bricks it is very difficult to ensure perfect solidity and to guard against the existence of any air holes & flaws in the waists of the specimens. The area of 2.25 sq inches being so small air holes aggregating one eighth or  $\frac{1}{8}$  of a square inch in area would affect the strength very materially, - whereas in a larger specimen, the proportion of effective to theoretic cross section area would not be so great -

Para 8. As all the bricks were put in water immediately after they were made, the results do afford evidence of the degree in which the characteristic [of rapid setting] was exhibited, and speak greatly in favor of the hydraulic energy of the cements experimented upon. In accordance with the Chief Engineer's suggestion, however, experiments have been instituted of air drying for various lengths of time not exceeding 24 hours, & immersion for similar varying periods under water, and

and these are now in progress.

Para 9. As the experiments have hitherto been on such a small scale, it has been impossible to ascertain the cost of burning the different descriptions of limestone so as to be of any practical use. In my opinion, the mechanical mixture of burnt lime and soorkhee is the one that can most easily be adopted on all hydraulic works. The soorkhee can be prepared from the description of clay found to combine best with the lime. The burnt clay should be ground to a fine impalpable powder in one of Wills' Patent Portable Soorkhee Mills and kept in stock for issue to the works in the same manner as lime and sand are at present. I have the honor to request therefore that the mill are required <sup>against what</sup> which has already been indented for head of account from Calcutta may be supplied as soon as possible. There is ample room on the main Canal Lunka east of the Dry Dock for establishing the soorkhee factory and manufacturing

\* This is a mis-

take. Instructions  
are required  
to charge the  
mills if pur-  
chased.

L.P.

manufacturing concrete blocks for building.

The steam mill which has been obtained from Dumagudiem is used more for milling mortar and is not, I consider, adapted for crushing loorkhee, for which the ordinary Coffee mill arrangement, improved upon in Mr Wells' machine, is more suited.

I have the honor to be  
Yrs R. R. E. Brockman Capt. R.E.

Executive Engineer Godavari

(True Copy)

L. Beatty Major R.E.  
District Engineer Godavari.

P. M. 8093/111  
11/10/21

Burnt Lime-stone mixed with burnt clay.

| Quarry channel clay.              |                         |                   |   | Godavery river silt.              |                         |                   |   |
|-----------------------------------|-------------------------|-------------------|---|-----------------------------------|-------------------------|-------------------|---|
| Days old.                         | Indiscriminately mixed. |                   |   | Days old.                         | Indiscriminately mixed. |                   |   |
|                                   | 1 B.L. to 1 B.C.        |                   |   |                                   | 1 B.L. to 1 B.C.        |                   |   |
| 7                                 | "                       | 114 $\frac{3}{4}$ | " | 7                                 | "                       | 168 $\frac{1}{4}$ | " |
| 14                                | "                       | 208 $\frac{3}{4}$ | " | 14                                | "                       | 245               | " |
| 21                                | "                       | 252 $\frac{1}{2}$ | " | 21                                | "                       | 270 $\frac{3}{4}$ | " |
|                                   |                         | 192               |   |                                   |                         | 228               |   |
| D. 1 B.L. to 1 $\frac{1}{2}$ B.C. |                         |                   |   | D. 1 B.L. to 1 $\frac{1}{2}$ B.C. |                         |                   |   |
| 7                                 | "                       | 138 $\frac{1}{2}$ | " | 7                                 | "                       | 173 $\frac{1}{2}$ | " |
| 14                                | "                       | 240 $\frac{3}{4}$ | " | 14                                | "                       | 266 $\frac{3}{4}$ | " |
| 21                                | "                       | 283 $\frac{1}{2}$ | " | 21                                | "                       | 282 $\frac{1}{4}$ | " |
|                                   |                         | 221               |   |                                   |                         | 241               |   |
| D. 1 B.L. to 1 $\frac{1}{2}$ B.C. |                         |                   |   | D. 1 B.L. to 1 $\frac{1}{2}$ B.C. |                         |                   |   |
| 7                                 | "                       | 159 $\frac{1}{4}$ | " | 7                                 | "                       | 185 $\frac{1}{4}$ | " |
| 14                                | "                       | 296 $\frac{1}{2}$ | " | 14                                | "                       | 238 $\frac{1}{4}$ | " |
| 21                                | "                       | 325 $\frac{1}{2}$ | " | 21                                | "                       | 270 $\frac{1}{4}$ | " |
|                                   |                         | 260               |   |                                   |                         | 231               |   |
| D. 1 B.L. to 1 $\frac{3}{4}$ B.C. |                         |                   |   | D. 1 B.L. to 1 $\frac{3}{4}$ B.C. |                         |                   |   |
| 7                                 | "                       | 158               | " | 7                                 | "                       | 165 $\frac{1}{2}$ | " |
| 14                                | "                       | 270 $\frac{3}{4}$ | " | 14                                | "                       | 231 $\frac{1}{4}$ | " |
| 21                                | "                       | 310 $\frac{1}{2}$ | " | 21                                | "                       | 262 $\frac{1}{2}$ | " |
|                                   |                         | 246               |   |                                   |                         | 220               |   |
| D. 1 B.L. to 2 B.C.               |                         |                   |   | D. 1 B.L. to 2 B.C.               |                         |                   |   |
| 7                                 | "                       | 128 $\frac{1}{4}$ | " | 7                                 | "                       | 198 $\frac{1}{2}$ | " |
| 14                                | "                       | 193 $\frac{1}{4}$ | " | 14                                | "                       | 284               | " |
| 21                                | "                       | 246               | " | 21                                | "                       | 269               | " |
|                                   |                         | 189               |   |                                   |                         | 250               |   |

The bricks were immersed in water immediately, after within a quarter of an hour, after they were made

N. of bricks of each kind experimented on 4  
Area subjected to strain 2 1/2 square inches (1 1/2 x 1 1/2)

- A. Crystalline
- B. Semicrystalline
- C. Non-crystalline

Dowlaisheram  
Esq. Eng<sup>g</sup> Office  
7 November 1874

1/Secy R.R.E. Brochman Captain R.E.  
Executive Godavery

( Truecopy )  
L. Peatty. Major R.E.  
District Engineer Godavery

O. M. 8093/74  
 21/2/20/34

<sup>1/2</sup> IV  
 Cement Experiments.

Burnt Lime Stone in powder mixed with raw clay in  
 powder & reburnt.

| Days old                    | A                 | B   | C   | Days old                     | A   | B   | C                 | Days old                     | A   | B   | C   |
|-----------------------------|-------------------|-----|-----|------------------------------|-----|-----|-------------------|------------------------------|-----|-----|-----|
| All lime                    |                   |     |     | 1 B.L. - $\frac{3}{4}$ P.C.  |     |     |                   | 1 B.L. - $1\frac{1}{2}$ P.C. |     |     |     |
| 14                          | 24                | 13  | "   | 7                            | 165 | 106 | 99                | 7                            | 155 | 227 | 164 |
| 21                          | 40                | 18  | "   | 14                           | 192 | 158 | 163               | 14                           | 231 | 287 | 246 |
|                             |                   |     |     | 21                           | 227 | 191 | 206               | 21                           | 247 | 303 | 287 |
|                             |                   |     |     |                              | 194 | 155 | 155               |                              | 211 | 275 | 232 |
| Mixed lime                  |                   |     |     | 1 B.L. - 1 P.C.              |     |     |                   | 1 B.L. - 2 P.C.              |     |     |     |
| 14                          | 14                | "   | "   | 7                            | 172 | 117 | 129 $\frac{1}{2}$ | 7                            | 140 | 188 | 172 |
| 21                          | 32                | "   | "   | 14                           | 212 | 202 | 254 $\frac{2}{3}$ | 14                           | 217 | 256 | 250 |
|                             |                   |     |     | 21                           | 261 | 230 | 283               | 21                           | 250 | 281 | 294 |
|                             |                   |     |     |                              | 215 | 188 | 222               |                              | 252 | 271 | 258 |
| 1 B.L. - $\frac{1}{4}$ P.C. |                   |     |     | 1 B.L. - $1\frac{1}{4}$ P.C. |     |     |                   |                              |     |     |     |
| 7                           | 75                | 27  | 62  | 7                            | 187 | 190 | 168               |                              |     |     |     |
| 14                          | 103               | 73  | 98  | 14                           | 249 | 235 | 235               |                              |     |     |     |
| 21                          | 181 $\frac{1}{2}$ | 112 | 115 | 21                           | 269 | 251 | 268               |                              |     |     |     |
|                             | 119               | 70  | 91  |                              | 235 | 232 | 233               |                              |     |     |     |
| 1 B.L. - $\frac{1}{2}$ P.C. |                   |     |     | 1 B.L. - $1\frac{1}{2}$ P.C. |     |     |                   |                              |     |     |     |
| 7                           | 77                | 97  | 117 | 7                            | 173 | 212 | 166               |                              |     |     |     |
| 14                          | 160               | "   | 190 | 14                           | 260 | 225 | 238               |                              |     |     |     |
| 21                          | 194               | 73  | 208 | 21                           | 275 | 262 | 287               |                              |     |     |     |
|                             | 143               |     | 171 |                              | 233 | 233 | 231               |                              |     |     |     |

The bricks  
 in all cases  
 were immersed  
 immediately after  
 they were made,  
 or say within  $\frac{1}{4}$   
 of an hour.  
 No of bricks of  
 each kind  
 experimented  
 on - 4.

A. Crystalline  
 B. Semi-crystalline  
 C. Non-crystalline  
 Area subjected  
 to strain  $2\frac{1}{2}$  square  
 inches ( $1\frac{1}{2} \times 1\frac{1}{2}$ )

Dowlaishwaram  
 Engg<sup>n</sup> Office  
 7<sup>th</sup> November 1874

W. P. R. Brockman Capt. R.E.  
 Executive Engineer -

(True Copy)  
 L. P. Scatty Major R.E.  
 District Engineer Godavery.

CO 2/2007/11  
P. M. 8093/11

P. 105-8 A 15 R 11



Note by the Chief Engineer for Irrigation.

P.M. 6. 14 Sept 1911  
No. 2606.

The further information regarding cement experiments at Dowlaishivaram corrects some of the deductions made from the tables before furnished, in connection with which certain essential particulars had not then been reported. All the important conditions of the experiments should invariably be noted on each table showing the results, and they have now been taken from the correspondence and inserted in the tables.

2. The general result so far is that, while bricks of lime only may be taken as capable of bearing a strain of from 20 to 30 lbs, those formed of lime and clay in various proportions have a strength of from 150 to 250 lbs on the 2 1/2 square inches of area subjected to tension. The accompanying tables Nos. III and IV give particulars of experiments with unselected burnt lime mixed with burnt clay, and with burnt lime mixed with raw clay in powder and reburied. As before concluded the simplest plan appears to be to mix burnt lime with burnt clay, but it will depend upon cheapness of manufacture which method

method should be adopted, seeing that all the ways of mixing clay and lime hitherto tried have given fairly satisfactory results. To the question therefore of economical manufacture great attention should now be paid. From a demi-official note from Major Beatty it appears that grinding the burnt clay has cost Rupees 2.12.0 a Cubic yard, or twice as much as burning it. With the Wells patent mills, which have recently been sanctioned, no doubt this part of the process will cost very much less, and but for the fact that the experiments have been on a very small scale, and the quantity of materials used very limited, the process of breaking and grinding clay exclusively by hand would have been inappropriate.

3. Both Captain Brockman and Major Beatty attach very little importance to the selection or separation of the 3 marked varieties of lime which are found together in each of the two quarries from which the Eastern and Western Delta limekilns are supplied. They point to the analogous chemical composition of the most highly crystalline and the amorphous or non-crystalline limes in the case of Nos 8 and 14 of the specimens analysed by Mr. Sejourne, and Captain Brockman notices that it would be expensive

16 17  
expensive to work only one vein when the limes are found so much mixed up together in the quarries. The reasons on which a separation was advocated, and the way in which this separation was to be effected, have however not been fully understood. The one apparent reason for separation was the probability that these stones of widely different mechanical structure required differing degrees of heat to burn them properly, that consequently to burn one thoroughly would be to overburn the other, so that first there would be a deterioration of quality in the out turn of this mixed lime, and secondly a waste of fuel. The time of separation moreover was to be not in quarrying, but when breaking up the stone at the kilns preparatory to burning, and then no addition to the cost would be involved.

4. Practical use has already been made of the artificial cement at the Chopella lock on the Panke Canal, Eastern Delta, and

and the results are stated to be satisfactory.

Then the way of using it is reported to be -

First to mix 1 lime and 2 sand together, and

then to add 1 burnt clay - This is a reversal

of the usual order of mixing, and a few

bricks formed in each way would soon

indicate whether the clay or the sand

should first be mixed with the lime.

5. Information regarding the cost of

preparing burnt clay powder will soon be

available, and this in full detail with

weights of clay and fuel used in a kiln -

charge, and the cost of each item of the pro-

cess, will be of great and general value,

as all over the Country a similar use of

burnt clay in all hydraulic masonry

works is to be desired, and will, when

the means of preparing it are available,

be enforced - As yet only a very rude

kiln, of indifferent proportions for econo-

mizing heat and fuel, has been used

at

at Dowlaichwaram, and a good model adap-

ted for use anywhere and everywhere will

it is hoped soon be designed by Captain

Brockman - Sun-dried bricks in mud will

probably be the best material to use in its con-

struction

Camp at Akter  
15<sup>th</sup> December 1874

Wentworth  
Chief Engineer for Irrigation  
Lieut. Col. R.E.

Public Works 1874. Department  
Proposed for Canal  
No. 8093

From  
The Chief Engineer  
for Irrigation  
To The Secretary to Govt.  
P. W. D.  
No. 1058A

Dated 15<sup>th</sup>  
Recd 28<sup>th</sup> Dec. 74  
Encls 4.

Note on the fur-  
ther report on cement-  
experiments made at  
Dowlashevaram.

Qd. No: 174. 21-1-75.

No 359

C. 30<sup>th</sup> Dec 1874

18  
P. W. Dept.  
Proceedings of the Madras Government.  
Read the following:-  
From the Chief Engineer  
for Irrigation } (N.S. No. 1058A d/15<sup>th</sup> Dec 74)

174.

These papers will be printed  
and communicated to all Super-  
intending and District Engineers  
in continuation of Proceedings  
Madras Government of the 14<sup>th</sup>  
September 1874. No. 2606.

by 15/1/75  
G.W.

To the Distt. Engr. Godavery. ✓  
" " Ch. Engr. for Irrigation. ✓  
To all Super. & Distt. Engineers. ✓  
The Engineer Wynand ✓  
Respt. to all 23/1/75.

307  
Govt. of 1874 Madras.  
PUBLIC WORKS.

To

The Dt. Engr.  
Godavery

Dated

Recd.

Encl. 4

G. O. 21<sup>st</sup> Jan 1875, No. 174

Nos. 358-360

Memorandum to Experiments

Papers relating to the  
current experiments  
at Godavari  
are ordered to be  
printed & sent to all  
Super and District Engrs.