

# Resource C

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## PAPER 2

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### KIRKALDY'S TESTS ON PORTIONS OF THE TAY BRIDGE

## TAY BRIDGE DISASTER:

## No. 16.

## RESULTS OF TESTS made by Mr. KIRKALDY upon PORTIONS of the TAY BRIDGE.

RESULTS OF EXPERIMENTS to ascertain the ULTIMATE TENSILE STRENGTH and RATES of EXTENSION of SIX IRON BOLTS and NUTS, received per HENRY LAW, Esq., C.E.

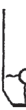
| Test No. | Description. | Length between Head and Nut. | Dimensions over Thread. |         | Total Stress in Pounds—Extension Inch. |        |        |        |        |        |        |        |        |        |        |        | Ultimate. |        |        | Appearance of Fracture. |           |        |                   |                             |           |
|----------|--------------|------------------------------|-------------------------|---------|----------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----------|--------|--------|-------------------------|-----------|--------|-------------------|-----------------------------|-----------|
|          |              |                              | Diam.                   | Area.   | 10,000                                 | 12,000 | 14,000 | 16,000 | 18,000 | 20,000 | 22,000 | 24,000 | 26,000 | 28,000 | 30,000 | 32,000 | 34,000    | 36,000 | 38,000 |                         |           | 40,000 | Ex-tension Total. | Stress.                     |           |
|          |              |                              |                         |         |                                        |        |        |        |        |        |        |        |        |        |        |        |           |        |        | Total.                  | Persq.in. |        |                   |                             |           |
| O        |              | inches.                      | inch.                   | sq. in. |                                        |        |        |        |        |        |        |        |        |        |        |        |           |        |        |                         |           |        | lbs.              | lbs.                        | per cent. |
| 1435     | Unmarked     | 3.60                         | 1.13                    | 1.003   | .023                                   | .027   | .031   | .040   | .046   | .051   | .057   | .062   | .067   | .071   | .077   | .082   | .091      | .106   | .130   | .170                    | .231      | 40,810 | 40,687            | 45 Fibrous, 55 Crystalline. |           |
| 1436     | "            | 4.20                         | "                       | "       | .016                                   | .020   | .026   | .032   | .040   | .046   | .052   | .058   | .064   | .071   | .081   | .100   | .122      | .151   | .190   | —                       | .262      | 39,720 | 39,601            | 97 " 3 "                    |           |
| 1438     | "            | 3.80                         | "                       | "       | .017                                   | .021   | .026   | .031   | .038   | .042   | .048   | .052   | .057   | .061   | .067   | .072   | .080      | .090   | .106   | —                       | .138      | 39,610 | 39,491            | 0 " 100 "                   |           |
| 1434     | "            | 3.80                         | "                       | "       | .020                                   | .025   | .030   | .037   | .044   | .050   | .056   | .061   | .068   | .074   | .080   | .088   | .098      | .118   | —      | —                       | .126      | 36,115 | 36,006            | 40 " 60 "                   |           |
| 1432     | "            | 3.80                         | "                       | "       | .015                                   | .018   | .021   | .024   | .028   | .032   | .038   | .044   | .050   | .056   | .060   | .066   | .071      | —      | —      | —                       | .097      | 35,755 | 35,648            | 0 " 100 "                   |           |
| 1431     | "            | 3.80                         | "                       | "       | .014                                   | .022   | .031   | .040   | .046   | .052   | .060   | .065   | .071   | .078   | .088   | .104   | .125      | —      | —      | —                       | .222      | 34,825 | 34,720            | 88 " 12 "                   |           |
| Mean     | —            | —                            | —                       | —       | .018                                   | .022   | .028   | .034   | .040   | .045   | .052   | .057   | .063   | .068   | .075   | .085   | .098      | —      | —      | —                       | .179      | 37,806 | 37,692            | 45 " 55 "                   |           |
|          |              |                              |                         |         |                                        |        |        |        |        |        |        |        |        |        |        |        |           |        |        |                         |           | Tons.  | Tons.             | 16.9 16.8                   |           |

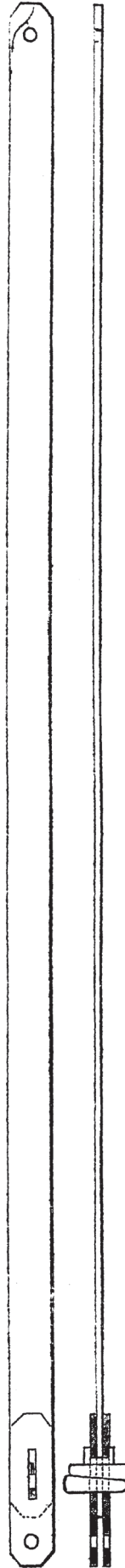
H. C. ROTHERY, Esq., F.L.S., M.R.S.L., F.R.M.S.  
 President of the Court of Inquiry,  
 Somerset House.

DAVID KIRKALDY,  
 99, Southwark Street, London, S.E.  
 21st April 1880.

APPENDIX.

RESULTS OF EXPERIMENTS TO ASCERTAIN THE RESISTANCE TO EXTENSION AND RUPTURE, UNDER A GRADUALLY INCREASED PULING STRESS OF THREE IRON TIE-BARS HAVING COUPLING-LINKS attached with COLLARS, RECEIVED PER HENRY LAW, ESQ., C.E.

| Test No. | Link Number. | Original Dimensions. | Sec-tional Area. | Length between Bolt-hole. | Total Stress on Link in Pounds—Extension Inch. |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | Ulti-mate Exten-sion. | Ultimate Stress. |         | Position of Fracture. |         |         |         |         |         |         |         |         |                                                                                                                                                                                                                                                                                                                                         |             |        |  |
|----------|--------------|----------------------|------------------|---------------------------|------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------------------|------------------|---------|-----------------------|---------|---------|---------|---------|---------|---------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------|--|
|          |              |                      |                  |                           | 10,000.                                        | 12,000. | 14,000. | 16,000. | 18,000. | 20,000. | 22,000. | 24,000. | 26,000. | 28,000. | 30,000. | 32,000. | 34,000. | 36,000. | 38,000. | 40,000. |                       | 42,000.          | 44,000. |                       | 46,000. | 48,000. | 50,000. | 52,000. | 54,000. | 56,000. | 58,000. | 60,000. | Total.                                                                                                                                                                                                                                                                                                                                  | Per sq. in. |        |  |
| O        |              | inches.              | sq. in.          | in.                       |                                                |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |                       |                  |         |                       |         |         |         |         |         |         | lbs.    | lbs.    |     |             |        |  |
| 1415     | Unmarked     | 4.47 x .51           | 2.279            | 135.7                     | .070                                           | .090    | .109    | .128    | .150    | .171    | .190    | .210    | .230    | .255    | .280    | .300    | .326    | .355    | .378    | .408    | .430                  | .460             | .480    | .525                  | .570    | .620    | .680    | .738    | —       | —       | —       | 0.76    | 56,692                                                                                                                                                                                                                                                                                                                                  | 24,875      |        |  |
| 1417     | "            | 4.47 x .51           | 2.279            | 125.3                     | .112                                           | .148    | .177    | .188    | .211    | .229    | .248    | .260    | .280    | .300    | .320    | .338    | .360    | .380    | .400    | .420    | .450                  | .485             | .525    | .570                  | .625    | .688    | .810    | .900    | .992    | —       | —       | —       | 1.12                                                                                                                                                                                                                                                                                                                                    | 59,524      | 26,118 |  |
| 1419     | "            | 4.50 x .49           | 2.205            | 125.2                     | .100                                           | .149    | .218    | .246    | .270    | .290    | .320    | .342    | .370    | .396    | .428    | .460    | .498    | .525    | .560    | .596    | .638                  | .680             | .738    | .788                  | .850    | .911    | .972    | 1.07    | —       | —       | —       | 1.16    | 56,488                                                                                                                                                                                                                                                                                                                                  | 25,618      |        |  |



| Test No.         | Test No.         | SUMMARY OF RESULTS OF SECOND EXPERIMENTS TO ASCERTAIN THE QUALITY OF THE IRON.                                                                                                                             |   |
|------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 1st Experi-ment. | 2nd Experi-ment. |                                                                                                                                                                                                            |   |
| 0.1415           | 0.1416           | Bar broke with 99,810 lbs. = 43,795 lbs. or 19.55 tons per square inch, contraction of area at fracture 10.53 per cent., extension 6.6 per cent., fracture 70 per cent. fibrous, 30 per cent. crystalline. |   |
| 0.1417           | 0.1418           | "                                                                                                                                                                                                          | " |
| 0.1419           | 0.1420           | "                                                                                                                                                                                                          | " |

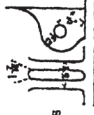
H. C. ROTHERY, Esq., F.L.S., M.R.S.L., F.R.M.S.,  
President of the Court of Inquiry,  
Somerset House.

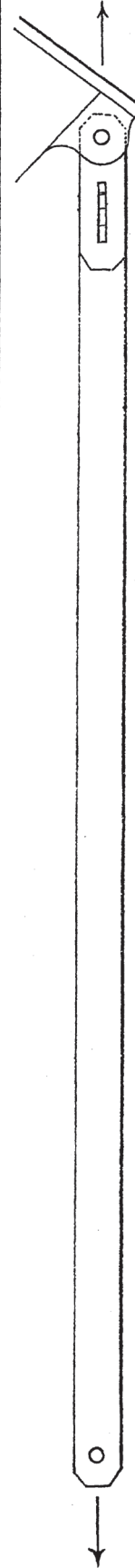
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99, Southwark Street, London, S.E.,  
22nd April 1880.

lix 105

## TAY BRIDGE DISASTER:

Results of Experiments to ascertain the Resistance to Extension and Rupture, under a gradually increased Pulling Stress of Column-Lugs attached with Bolt to Tie-Bars and Coupling-Lugs and Collars, received per HENRY LAW, Esq., C.E.

| Test No. | Description.                                                                        | Total Stress on Lugs and Links in Pounds.—Extension Inch. |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | Ultimate Stress. |         | Position of Fracture. |         |         |         |         |                     |                   |                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|          |                                                                                     | 10,000.                                                   | 12,000. | 14,000. | 16,000. | 18,000. | 20,000. | 22,000. | 24,000. | 26,000. | 28,000. | 30,000. | 32,000. | 34,000. | 36,000. | 38,000. | 40,000. | 42,000. | 44,000. | 46,000. | 48,000. | 50,000.          | 52,000. |                       | 54,000. | 56,000. | 58,000. | 60,000. | Ultimate Extension. | When Links broke. | When Lugs broke. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0        |  |                                                           |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |                  |         |                       |         |         |         |         |                     |                   |                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



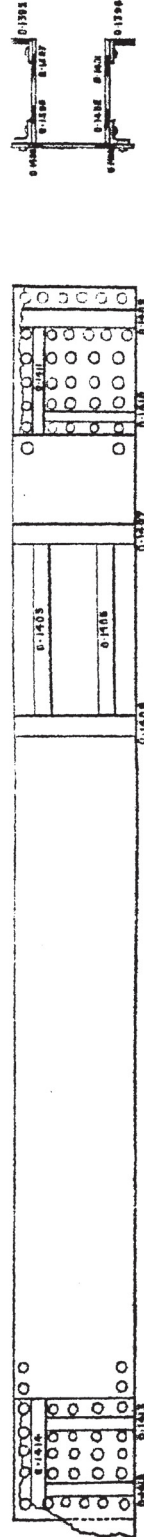
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30th April 1880.

APPENDIX

RESULTS OF EXPERIMENTS TO ASCERTAIN THE TENSILE STRENGTH AND QUALITY OF THE IRON USED IN RIVETED GIRDER, MARKED NO. 10, RECEIVED PER H. LAW, ESQ., C.E.

| Test No. | Description.            | Original.   |              | Ultimate Stress. |                                   | Size.               | Fractured.   |             | Stress per Sq. Inch of Fractured Area. | Extension in 10 Inches. |           | Appearance of Fracture.                         |
|----------|-------------------------|-------------|--------------|------------------|-----------------------------------|---------------------|--------------|-------------|----------------------------------------|-------------------------|-----------|-------------------------------------------------|
|          |                         | Size.       | Area.        | Total.           | Per Square Inch of Original Area. |                     | Area.        | Difference. |                                        | Inch.                   | Per Cent. |                                                 |
| 1397     | Side web plate          | 2'00" x .39 | sq. in. .780 | lbs. 40,105      | 51,416                            | inches. 1'95" x .34 | sq. in. .663 | .117        | 15'0                                   | 0'98                    | 9'8       | Fibrous, 25 per cent. crystalline.              |
| 1398     |                         | do.         | do.          | 41,310           | 52,188=23'8                       | 1'95" x .34         | .663         | .117        | 15'0                                   | 1'03                    | 10'3      | " 15 "                                          |
| 1399     |                         | do.         | do.          | 32,865           | 42,134                            | 1'99" x .37         | .736         | .044        | 5'6                                    | 0'19                    | 1'9       | " 15 "                                          |
| 1400     |                         | do.         | do.          | 33,710           | 43,217                            | 1'99" x .37         | .736         | .044        | 5'6                                    | 0'26                    | 2'6       | " 15 "                                          |
| 1401     | Side web plate          | 2'00" x .38 | sq. in. .760 | lbs. 42,180      | 55,486                            | 1'95" x .33         | .648         | .117        | 15'8                                   | 1'08                    | 10'3      | 45 per cent. fibrous, 55 per cent. crystalline. |
| 1402     |                         | do.         | do.          | 41,905           | 56,188                            | 1'93" x .33         | .637         | .123        | 16'1                                   | 1'11                    | 11'1      | Fibrous, 30 per cent. crystalline.              |
| 1403     |                         | do.         | do.          | 33,645           | 44,269                            | 1'99" x .37         | .736         | .024        | 3'1                                    | 0'16                    | 1'6       | " 10 "                                          |
| 1404     |                         | do.         | do.          | 33,210           | 43,697                            | 1'99" x .37         | .736         | .024        | 3'1                                    | 0'14                    | 1'4       | " 5 "                                           |
| 1405     | Long top plate          | 2'00" x .41 | sq. in. .820 | lbs. 36,165      | 44,103                            | 1'95" x .38         | .741         | .079        | 8'4                                    | 0'61                    | 6'1       | Do.                                             |
| 1406     |                         | do.         | do.          | 37,570           | 45,817                            | 1'92" x .37         | .710         | .110        | 13'4                                   | 0'88                    | 8'8       | Do.                                             |
| 1407     |                         | do.         | do.          | 29,865           | 36,420                            | 1'98" x .40         | .792         | .028        | 3'4                                    | 0'22                    | 2'2       | Do.                                             |
| 1408     |                         | do.         | do.          | 30,920           | 37,707                            | 1'98" x .40         | .792         | .028        | 3'4                                    | 0'29                    | 2'9       | Do.                                             |
| 1409     | Fractured plates        | 2'00" x .42 | sq. in. .840 | lbs. 44,890      | 53,440                            | 1'96" x .37         | .725         | .115        | 13'6                                   | 0'74                    | 7'4       | 50 per cent. fibrous, 50 per cent. crystalline. |
| 1410     |                         | do.         | do.          | 40,865           | 48,648                            | 1'98" x .40         | .792         | .048        | 5'7                                    | 0'33                    | 3'3       | 75 " 25 "                                       |
| 1411     |                         | do.         | do.          | 39,180           | 46,630                            | 1'99" x .41         | .816         | .024        | 2'8                                    | 0'14                    | 1'4       | 50 per cent. fibrous, 30 per cent. crystalline. |
| 1412     |                         | do.         | do.          | 37,315           | 45,098                            | 1'99" x .37         | .736         | .024        | 3'1                                    | 0'17                    | 1'7       | 75 " 25 "                                       |
| 1413     | Diagonal plate, N. 2 A. | 2'00" x .37 | sq. in. .740 | lbs. 38,090      | 51,472                            | 1'98" x .35         | .698         | .047        | 6'3                                    | 0'22                    | 2'2       | 65 " 35 "                                       |
| 1414     |                         | do.         | do.          | 39,510           | 51,966                            | 1'97" x .36         | .713         | .047        | 6'1                                    | 0'27                    | 2'7       | 60 " 40 "                                       |
| 1415     |                         | do.         | do.          | 56,420           | 51,890                            | 1'97" x .51         | 1'004        | .096        | 8'7                                    | 0'58                    | 5'8       | 10 " 90 "                                       |
| 1416     |                         | do.         | do.          | 57,805           | 52,650                            | 1'94" x .49         | .951         | .149        | 13'5                                   | 0'96                    | 9'6       | 70 " 30 "                                       |
| 1417     | Angles                  | 2'00" x .34 | sq. in. .680 | lbs. 49,855      | 45,922                            | 1'99" x .54         | 1'075        | .025        | 2'9                                    | 0'12                    | 1'2       | 92 " 8 "                                        |
| 1418     |                         | do.         | do.          | 47,710           | 43,372                            | 1'99" x .55         | 1'094        | .008        | 0'5                                    | 0'09                    | 0'9       | 95 " 5 "                                        |
| 1419     |                         | do.         | do.          | 86,885           | 54,243                            | 1'85" x .27         | .499         | .181        | 26'6                                   | 1'68                    | 16'8      | 20 " 80 "                                       |
| 1420     |                         | do.         | do.          | 86,595           | 52,378                            | 1'89" x .32         | .605         | .095        | 13'5                                   | 1'13                    | 11'3      | 5 " 95 "                                        |



AVERAGES.

| —                 | Strength per Sq. Inch. | Contraction.   | Extension.    | Fracture.                                       |
|-------------------|------------------------|----------------|---------------|-------------------------------------------------|
| Plates, lengthway | lbs. 51,192=23'8       | per cent. 11'4 | per cent. 7'1 | 67 per cent. fibrous, 33 per cent. crystalline. |
| " crossway -      | 43,186=19'28           | 3'2            | 1'7           | " 12 "                                          |
| Angles, lengthway | 53,260=23'77           | 20'0           | 14'0          | " 13 "                                          |

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3rd May 1880.

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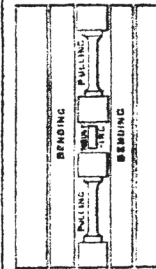
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4th May 1880.

APPENDIX.

SUMMARY OF RESULTS OF EXPERIMENTS, under PULLING, THRUSTING, and BENDING STRESSES, of SPECIMENS cut out of BROKEN CAST-IRON COLUMNS, received per HENRY LAW, Esq., C.E.

| Cut out of Column.  | Pulling Stress. |           |               |                             |           | Thrusting Stress. |           |       |         |                             | Bending Stress. |          |             |        |                 |       |                  |                     |            |                   |
|---------------------|-----------------|-----------|---------------|-----------------------------|-----------|-------------------|-----------|-------|---------|-----------------------------|-----------------|----------|-------------|--------|-----------------|-------|------------------|---------------------|------------|-------------------|
|                     | Test No.        | Diameter. | Area.         | Ultimate Stress per sq. in. | Fracture. | Test No.          | Diameter. | Area. | Length. | Ultimate Stress per sq. in. | Fracture.       | Test No. | Dimensions. |        | BD <sup>2</sup> | Span. | Ultimate Stress. |                     | Fracture.  |                   |
|                     |                 |           |               |                             |           |                   |           |       |         |                             |                 |          | Breadth.    | Depth. |                 |       | Total.           | Per BD <sup>2</sup> |            |                   |
| No. 1, 15" diameter | O 1354          | 1.128     | sq. in. 1.000 | lbs. 19,445                 | Sound.    | O 1356            | 1.128     | 1.000 | 2.00    | lbs. 77,620                 | Sound.          | O 1357   | 1.00        | 2.00   | 4.00            | 20    | lbs. 4,621       | lbs. 1,155          | inch. .134 | Sound.            |
|                     | 1355            | do.       | do.           | 19,255                      | do.       |                   |           |       |         |                             |                 | 1358     | do.         | do.    | do.             | do.   | 4,591            | 1,147               | .123       | do.               |
|                     | 1360            | do.       | do.           | 22,065                      | do.       | 1362              | do.       | do.   | do.     | 77,590                      | do.             | 1363     | do.         | do.    | do.             | do.   | 5,059            | 1,264               | .127       | do.               |
|                     | 1361            | do.       | do.           | 22,105                      | do.       |                   |           |       |         |                             |                 | 1364     | do.         | do.    | do.             | do.   | 5,189            | 1,297               | .138       | do.               |
| No. 2, do.          | 1366            | do.       | do.           | 19,655                      | do.       | 1368              | do.       | do.   | do.     | 76,840                      | do.             | 1369     | do.         | do.    | do.             | do.   | 4,556            | 1,139               | .136       | Slightly unsound. |
|                     | 1367            | do.       | do.           | 19,810                      | do.       |                   |           |       |         |                             |                 | 1370     | do.         | do.    | do.             | do.   | 4,738            | 1,184               | .142       | Sound.            |
| No. 6, do.          | 1372            | do.       | do.           | 20,820                      | do.       | 1374              | do.       | do.   | do.     | 74,720                      | do.             | 1376     | do.         | do.    | do.             | do.   | 4,631            | 1,158               | .128       | do.               |
|                     | 1373            | do.       | do.           | 20,708                      | do.       |                   |           |       |         |                             |                 | 1377     | do.         | do.    | do.             | do.   | 4,638            | 1,159               | .128       | do.               |
| No. 7, do.          | 1379            | do.       | do.           | 20,110                      | do.       | 1381              | do.       | do.   | do.     | 77,380                      | do.             | 1382     | do.         | do.    | do.             | do.   | 4,621            | 1,155               | .139       | do.               |
|                     | 1380            | do.       | do.           | 20,040                      | do.       |                   |           |       |         |                             |                 | 1383     | do.         | do.    | do.             | do.   | 3,817            | 954                 | .111       | Unsound.          |
| No. 8, do.          | 1385            | do.       | do.           | 22,040                      | do.       | 1387              | do.       | do.   | do.     | 79,970                      | do.             | 1388     | do.         | do.    | do.             | do.   | 3,296            | 824                 | .082       | do.               |
|                     | 1386            | do.       | do.           | 22,185                      | do.       |                   |           |       |         |                             |                 | 1389     | do.         | do.    | do.             | do.   | 4,703            | 1,177               | .138       | Sound.            |
| 18" diameter        | 1390            | do.       | do.           | 20,205                      | do.       | 1392              | do.       | do.   | do.     | 76,550                      | do.             | 1393     | do.         | do.    | do.             | do.   | 3,189            | 797                 | .074       | Unsound.          |
|                     | 1391            | do.       | do.           | 18,185                      | Unsound.  |                   |           |       |         |                             |                 | 1394     | do.         | do.    | do.             | do.   | 4,982            | 1,245               | .152       | Sound.            |
| Mean                |                 |           |               | 20,478                      |           |                   |           |       |         | 77,524                      |                 |          |             |        |                 |       | 4,474            | 1,118               | .123       |                   |



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