Thermometrical Observations at Rose Bridge Colliery.

Date.	Depth, in yards.	Strata.	Temperature in open pit.	Temperature in solid strata.
			° F.	° F.
July 1854.	161	Blue shale	......	64·5
August 1854	188	Warrant earth	......	66
May 1858	550	Blue shale	......	78
July 1858	600	Warrant earth	......	80
May 18, 1868	630	"Raven" coal	73	83
July 24, 1868	665	Linn and wool	75	85
April 19, 1869.	673	"Yard Coal" mine	76	86
November 18, 1868.	700	Strong blue metal	76	87
February 22, 1869...	736	Do.	76	88½
March 12, 1869	748	Shale	77	89
April 17, 1869	762	Linn and wool, or strong shale.	78	90·5
May 3, 1869	774	Strong shale	80	91·5
May 19, 1869.........	782	Blue metal...........................	79	92
July 8, 1869	801	Strong blue shale	79	93
July 16, 1869.........	808	Coal (Arley mine).................	79	93½

Remarks.

All holes vertical in solid at bottom of pit drilled with water 1 yard deep, and thermometer remained in hole thirty minutes and made airtight with clay.

II. "On the Action of Rays of high Refrangibility upon Gaseous Matter." By John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution. Received December 4, 1869.

This paper is an expansion of the Researches already communicated to the Royal Society on the Chemical Action of Light on Gaseous Matter. (See Proceedings, vol. xvii. p. 92.)

III. "On the Theory of Continuous Beams." By John Mortimer Heppel, Mem. Inst. C.E. Communicated by Prof. W. J. Macquorn Rankine. Received December 9, 1869.

(Abstract.)

The chief object of the present communication is to remedy some acknowledged defects in the theory of the above-mentioned subject. The principal steps by which it has reached its present state of development are also noticed, and may be briefly recapitulated as follows:—

In 1825 M. Navier investigated the conditions of a straight continuous beam resting on any number of supports. His method, though perfectly correct for the assumed conditions (which embraced most cases occurring

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in practice), was so exceedingly intricate when the number of openings became at all large, that in such instances it was of little practical use.

In 1849 M. Clapeyron, a distinguished engineer and savant, devised a much more direct and easy means of treating such cases, though he did not at first succeed in giving to his own method all the simplicity and elegance of which it was capable.

This was first done in 1856 by M. Bertot, civil engineer, who, by effecting an elimination which had escaped Clapeyron, arrived at a remarkable equation which has been the key to all subsequent treatment of the subject. This equation involves the bending moments over any three consecutive points of support, and is well known in France by the name of the "Theorem of the three Moments."

In 1857 M. Clapeyron himself and M. Bresse, Professeur de Mécanique appliquée à l'École Impériale des Ponts et Chaussées, appear to have discovered this theorem independently of M. Bertot, and M. Bresse shortly afterwards extended it to a much greater degree of generality.

M. Bresse's researches on this subject are published in the third volume of his 'Cours de Mécanique appliquée,' Paris, 1865; but they had been communicated by him to the Academy of Sciences in 1862, and fully completed in the previous year. M. Bresse not only contributed to the advancement of the theory, but entered largely into the best methods of its application to practice, and framed rules which have since, under an Imperial Commission, acquired the character of legislative enactments.

M. Bélanger, Professeur de Mécanique appliquée à l'École centrale, appears, about the same time as M. Bresse, to have made an independent investigation of this subject, and to have brought the theory of it to about the same stage of advancement.

Little has been since added to this theory in France, but valuable contributions to its development in reference to practice are to be found in the works of MM. Renaudot, Albaret, Molinos et Pronnier, Colignon, and Piarron de Mondesir.

In England Professor Moseley is the first writer on mechanics who appears to have occupied himself with this subject. In his work on 'The Mechanical Principles of Engineering and Architecture,' he gives several examples of the application of M. Navier's method to important practical cases. This work was published in 1843, and no doubt furnished the groundwork for Mr. Pole's more extended investigations.

In 1852 Mr. Pole had to examine the case of the bridge over the Trent at Torksey, involving some new conditions not treated by Moseley, but which he found the means of treating with perfect success. About the same time Mr. Pole had to deal with the much more complex and important case of the Britannia bridge, in which, besides variation of load from one span to another, variation of section also had to be considered, and imperfect continuity over the middle pier. These conditions were successfully imported into this method of Navier, which was, however,

only known to Mr. Pole through the examples of its application given in Moseley's work, and the results obtained were identical with those which would have followed from the application of the method of Clapeyron in its most improved and generalized form.

In 1858, the present writer, being then in India, had occasion to consider the condition of a continuous girder of five spans, and finding the method of Navier unmanageable, was forced to seek for some other. He first came upon the equation which he afterwards found had been for some years known in France as the "Theorem of the three Moments," and afterwards extended it, so as to take in all the conditions of the Britannia bridge and to verify all Mr. Pole's results. In this form it was absolutely identical with the equation given by M. Bélanger, and nearly so with that of M. Bresse.

The great defect in all this theory up to the present time has been that, in order to avoid an inextricable complexity, it has been necessary to consider the load in each span as uniformly distributed over it, and the moment of inertia of the section as uniform throughout each span.

In many cases these hypotheses are false, notably so in the case of the Britannia; and the conclusions are affected by their falsity, to what extent being a matter of uncertainty, though good grounds have been shown for believing that the errors cannot attain to importance.

The method now given treats these conditions, it is hoped, rigorously; and although the equations obtained are such as necessarily require some laborious computation to obtain numerical results, they are certainly by no means inextricable.

It is satisfactory to find that in the case of the Britannia, where these new conditions enter with much greater force than in most cases, their effect on the resulting stresses is very unimportant; so that the inference may legitimately be drawn that in all ordinary cases the method of Bresse may be confidently applied.

It is scarcely possible in a short abstract to give an idea of an analytical investigation. The equations obtained are of the same form as those of the previous methods, each containing, as unknown quantities, the bending moments over three consecutive supports; but the coefficients are somewhat involved functions of the varying loads and sections. An abbreviated functional notation has, wherever possible, been used, by means of which a certain degree of clearness and symmetry is preserved in expressions which would otherwise become inextricably complex.

IV. "Remarks on Mr. Heppel's Theory of Continuous Beams." By W. J. Macquorn Rankine, C.E., LL.D., F.R.S. Received December 22, 1869.

(Abstract.)

The author states that the advantages possessed by Mr. Heppel's method will probably cause it to be used both in practice and in scientific study.