|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 4 | *5* | 6 | 7 | 8 | A |
| 7 | 5312 | 11525 | 18950 | 32200 | 47649 | 11525 |
| 8 | 4550 | 9787 | 15525 | 26050 | 39750 | 10085 |
| 9 | 4025 | 8308 | 13150 | 22350 | 32800 | 8964 |
| 10 | 36l2 | 7125 | 11250 | 19475 | 27750 | 8068 |
| 12 | 2987 | 6075 | 9100 | 16175 | 23450 | 6723 |
| 14 |  | 5300 | 7475 | 13225 | 19775 | 5763 |
| 16 |  | 4350 | 6362 | 11000 | 16375 | 5042 |
| 18 |  | 3700 | 5562 | 9245 | 13200 | 4482 |
| 20 |  | 3225 | 4950 | 8375 | 11487 | 4034 |
| 22 |  | 2975 |  |  |  | 3667 |
| 24 |  | 2162 |  |  |  | 3362 |
| 28 |  | 1775 |  |  |  | 2881 |

Mr Buffon had found by numerous trials that oak-timber lost much of its ſtrength in the courſe of drying or ſeaſoning; and therefore, in order to ſecure uniformity, his trees were all felled in the ſame ſeaſon of the year, were ſquared the day after, and tried the third day. Trying them in this green state gave him an opportunity of obſerving a very curious and unaccountable phenomenon. When the weights were laid briſkly on, nearly ſufficient to break the log, a very senſible ſmoke was obſerved to iſſue from the two ends with a sharp hiſſing noiſe. This continued all the while the tree was bending and cracking. This ſhows that the log is af­fected or ſtrained through its whole length ; indeed this muſt be inferred from its bending through its whole length. It alſo ſhows us the great effects of the compreſſion. It is a pity Mr Buffon did not take notice whether this ſmoke iſſued from the upper or compreſſed half of the ſection only, or whether it came from the whole.

We muſt now make ſome obſervations on theſe experi­ments, in order to compare them with the theory which we have endeavoured to eſtabliſh.

Mr Buffon conſiders the experiments with the 5-inch bars as the ſtandard of companion, having both extended theſe to greater lengths, and having tried more pieces of each length.

Our theory determines the relative ſtrength of bars of the same ſection to be inverſely as their lengths. But (if we except the five experiments in the firſt column) we find a very great deviation from this rule. Thus the 5-inch bar of 28 feet long ſhould have half the ſtrength of that of 14 feet, or 2650; whereas it is but 1775. The bar oſ 14 feet ſhould have half the ſtrength of that of 7 feet, or 5762 ; whereas it is but 5300. In like manner, the fourth of 11525 is 2881 ; but the real ſtrength of the 28-feet bar is 1775. We have added a column A, which exhibits the ſtrength which each of the 5-inch bars ought to have by the theory. This deviation is moſt diſtinctly ſeen in fig. 22. where BK is the ſcale of lengths, B being at the point 7 of the ſcale and K at 28. The ordinate CB is = 11525, and the other ordinates DE, GK, &c. are reſpectively = 7CB/Length. The lines DF, GH, &c. are made = 4350, 1775, &c. expressing the ſtrengths given by experiment. The 10-feet bar and the 24-feet bar are remarkably anoma­lous. But all are deficient, and the defect has an evident progreſſion from the firſt to the laſt. The ſame thing may be ſhown of the other columns, and even of the firſt, though it is very ſmall in that column. It may alſo be obſerved in the experiments of Belidor, and in all that we have ſeen. We cannot doubt therefore of its being a law of nature, de­pending on the true principles of coheſion and the laws of mechanics.

But it is very puzzling, and we cannot pretend to give a satisfactory explanation of the difficulty. **The** only effect which we can conceive the length of a beam to have, is to increaſe the ſtrain at the ſection of fracture by employing the intervening beam as a lever. But we do not diſtinctly ſee what change this can produce in the mode of action of the fibres in this ſection, ſo as either to change their coheſion or the place of its centre of effort; yet ſomething of this kind muſt happen.

We ſee indeed ſome circumſtances which muſt contribute to make a ſmaller weight ſufficient, in Mr Buffon’s experi­ments, to break a long beam than in the exact inverſe pro­portion of its length.

In the firſt place, the weight of the beam itſelf augments the ſtrain as much as if half of it were added in form of a weight. Mr Buffon has given the weights of every beam on which he made experiments, which is very nearly 74 pounds *per* cubic foot. But they are much too ſmall to account for the deviation from the theory. The half weights of the 5-inch beams of 7, 14, and 28 feet length are only 45, 92, and 182 pounds; which makes the real ſtrains in the experiments 11560, 5390, and 1956; which are far from having the proportions oſ 4, 2, and 1.

Buffon ſays that healthy trees are univerſally ſtrongeſt at the root end ; therefore, when we uſe a longer beam, ita middle point, where it is broken in the experiment, is in a weaker part of the tree. But the trials of the 4-inch beams ſhow that the difference from this cauſe is almost inſenſible.

The length muſt have ſome mechanical influence which the theory we have adopted has not yet explained. It may not however be inadequate to the taſk. The very ingeni­ous inveſtigation of the elaſtic curve by James Bernoulli and other celebrated mathematicians is perhaps as refined an ap­plication of mathematical analysis as we know. Yet in this inveſtigation it was neceſſary, in order to avoid almoſt inſuperable difficulties, to take the ſimpleſt poſſible caſe, viz. where the thickneſs is exceedingly ſmall in compariſon with the length. If the thickneſs be conſiderable, the quantities ne­glected in the calculus are too great to permit the conclusion to be accurate, or very nearly ſo. Without being able to define the form into which an elaſtic body of conſiderable thickneſs will be bent, we can ſay with confidence, that in an extreme caſe, where the compreſſion in the concave side is very great, the curvature differs conſiderably from the Bernoullian curve. But as our inveſtigation is incomplete and very long, we do not offer it to the reader. The fol­lowing more familiar conſiderations will, we apprehend, ren­der it highly probable that the relative ſtrength of beams decreaſes faſter than in the inverſe ratio of their length. The curious obſervation by Mr Buffon of the vapour which iſſued with a hiſſing noiſe from the ends of a beam of green oak, while it was breaking by the load on its middle, ſhows that the whole length of the piece was affected : indeed it muſt be, ſince it is bent throughout. We have ſhown above, that a certain definite curvature of a beam of a given form is always accompanied by rupture. Now ſuppoſe the beam A of 10 feet long, and the beam B of 20 feet long, bent to the ſame degree, at the place of their fixure in the wall ; the weight which hangs on A is nearly double of that which muſt hang on B. The form of any portion, ſuppoſe 5 feet, of theſe two beams, immediately adjoining to the wall, is conſiderably different. At the diſtance of 5 feet the cur­vature of A is 1/2 of its curvature at the wall. The curva­ture of B in the correſponding point is 3/4ths of the ſame cur­vature at the wall. Through the whole of the intermediate 5 feet, therefore, the curvature of B is greater than that of A. This muſt make it weaker throughout. It muſt occaſion the fibres to slide more on each other (that it may ac­quire t*his* greater curvature), and thus affect their lateral