If we suppose the body to be of a fibrous texture, having the fibres situated in the direction of the pressure, and slightly adhering to each other by some kind of cement, such a body will fail only by the bending of the fibres, by which they will break the cement and be detached from each other. Something like this may be supposed in wood­en pillars. In such cases, too, it would appear that the resistance must be as the number of equally resisting fibres, and as their mutual support, jointly ; and, therefore, as some function of the area of the section. The same thing must happen if the fibres be naturally crooked or undulated, as is observed in many woods, provided we suppose some simi­larity in their form. Similarity of some kind must always be supposed, otherwise we need never aim at any general in­ferences.

In all cases therefore we can hardly refuse admitting that the strength in opposition to compression is proportional to a function of the area of the section.

As the whole length of a cylinder or prism is equally pressed, it does not appear that the strength of a pillar is at all affected by its length. If indeed it be supposed to bend under the pressure, the case is greatly changed, be­cause it is then exposed to a transverse strain ; and this in­creases with the length of the pillar. But this will be con­sidered with due attention under the next class of strains.

Few experiments have been made on this species of strength and strain. Mr Pitot says that his experiments and those of Mr Parent show that the force necessary for crushing a body is nearly equal to that which will tear it asunder. He says that it requires something more than sixty pounds on every square line to crush a piece of sound oak. But the rule is by no means general : glass, for in­stance, will carry a hundred times as much as oak in this way, that is, resting on it ; but will not *suspend* four or five times as much. Oak will suspend a great deal more than fir ; but fir, as a pillar, will carry twice as much. Woods of a soft texture, although consisting of very tenacious fibres, are more easily crushed by their load. This soilness of tex­ture is chiefly owing to their fibres not being straight but undulated, and there being considerable vacuities between them, so that they are easily bent laterally and crushed. When a post is overstrained by its load, it is observed to swell sensibly in diameter. Increasing the load causes lon­gitudinal cracks or shivers to appear, and it presently after gives way. This is called *crippling.*

In all cases where the fibres lie oblique to the strain, the strength is greatly diminished, because the parts can then be made to slide on each other when the cohesion of the cementing matter is overcome.

Muschenbroeck has given some experiments on this subject ; but they are cases of long pillars, and therefore do not belong to this place. They will be considered af­terwards.

The only experiments of which we have seen any detail (and it is useless to insert mere assertions) are those of Mr Gauthey, in the fourth volume of Rozier’s *Journal de Physique.* This engineer exposed to great pressures small rectangular parallelopipeds, cut from a great variety of stones, and noted the weights which crushed them. The following table exhibits the medium results of many trials on two very uniform kinds of freestone, one of them among the hardest and the other among the softest used in building.

Column first expresses the length AB of the section, in French lines or 12ths of an inch; column second expresses the breadth BC ; column third is the area of the section, in square lines ; column fourth is the number of ounces required to crush the piece ; column fifth is the weight which was then borne by each square line of the section ; and column sixth is the round numbers to which Mr Gau­they imagines that those in column fifth approximate.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | *Hard Stone.* | | | | | 12 |
| AB.  8 | BC.  8 | ABxBC.  64 | Weight  736 | Force.  11∙5 |
| 2 | 8 | 12 | 96 | 2625 | 27∙3 | 24 |
| 3 | 8 | 16 | 128 | 4496 | 35∙1 | 36 |
|  |  |  | *Soft Stone.* | |  |  |
| 4 | 9 | 16 | 144 | 560 | 3∙9 | 4∙ |
| 5 | 9 | 18 | 162 | 848 | 5∙3 | 4∙5 |
| 6 | 18 | 18 | 324 | 2928 | 9∙ | 9∙ |
| 7 | 18 | 24 | 432 | 5296 | 12∙2 | 12∙ |

Little can be deduced from these experiments : the first and third, compared with the fifth and sixth, should furnish similar results ; for the first and fifth are respec­tively half of the third and sixth ; but the third is three times stronger (that is, a line of the third) than the first, whereas the sixth is only twice as strong as the fifth.

It is evident, however, that the strength increases much faster than the area of the section, and that a square line can carry more and more weight, according as it makes a part of a larger and larger section. In this series of ex­periments on the soft stone, the individual strength of a square line seems to increase nearly in the proportion of the section of which it makes a part.

Mr Gauthey deduces, from the whole of his numerous ex­periments, that a pillar of hard stone of Givry, whose sec­tion is a square foot, will bear with perfect safety 664,000 pounds, and that its extreme strength is 871,000; and the smallest strength observed in any of his experiments was 460,000. The soft bed of Givry stone had for its smallest strength 187,000, for its greatest 311,000, and for its safe load 249,000. Good brick will carry with safety 320,000 ; chalk will carry only 9000. The boldest piece of architecture in this respect which he has seen is a pil­lar in the church of All-Saints at Angers. It is twenty- four feet long and eleven inches square, and is loaded with 60,000, which is not one seventh of what is necessary for crushing it.

We may observe here by the way, that Mr Gauthey’s measure of the suspending strength of stone is vastly small in proportion to its power of supporting a load laid above it. He finds that a prism of the hard bed of Givry, of a foot section, is torn asunder by 4600 pounds ; and if it be firmly fixed horizontally in a wall, it will be broken by a weight of 56,000 suspended a foot from the wall. If it rest on two props at a foot distance, it will be broken by 206,000 laid on its middle. These experiments agree so ill with each other, that little use can be made of them. The subject is of great importance, and well deserves the attention of the patriotic philosopher.

A set of good experiments would be very valuable, be­cause it is against this kind of strain that we must guard by judicious construction in the most delicate and difficult problems which come through the hands of the civil and military engineer. The construction of stone arches, and the construction of great wooden bridges, and particularly the construction of the frames of carpentry called *centres* in the erection of stone bridges, are the most difficult jobs that occur. In the centres on which the arches of the bridge of Orleans were built, some of the pieces of oak were carrying upwards of two tons on every square inch of their scantling. All who saw it said that it was not able to carry the fourth part of the intended load. But the engineer understood the principles of his art, and ran the risk, and the result completely justified his confidence ; for the centre did not complain in any part, only it was found too supple ; so that it went out of shape while the haunches only of the arch were laid on it. The engineer corrected this by loading it at the crown, and thus kept it completely in shape during the progress of the work.

In the Memoirs of the Academy of St Petersburg for