1778, there is a dissertation by Euler on this subject, but particularly limited to the strain on columns, in which the bending is taken into the account. Mr Fuss has treated the same subject with relation to carpentry in a subsequent volume. But there is little in these papers besides a dry mathematical disquisition, proceeding on assumptions which (to speak favourably) are extremely gratuitous. The most important consequence of the compression is wholly overlooked, as we shall presently see. Our know­ledge of the mechanism of cohesion is as yet far too im­perfect to entitle us to a confident application of mathe­matics. Experiments should be multiplied.

The only way in which we can hope to make these experi­ments useful, is to pay a careful attention to the *manner* in which the fracture is produced. By discovering the general resemblances in this particular, we advance a step in our power of introducing mathematical measurement. Thus, when a cubical piece of chalk is slowly crushed between the chaps of a vice, we see it uniformly split in a surface oblique to the pressure, and the two parts then slide along the surface of fracture. This should lead us to exa­mine mathematically what relation there is between this surface of fracture and the necessary force ; then we should endeavour to determine experimentally the position of this surface. Having discovered some general law or resemblance in this circumstance, we should try what ma­thematical hypothesis will agree with this. Having found one, we may then apply our simplest notions of cohesion, and compare the result of our computations with experiment.

III. A BODY MAY BE BROKEN ACROSS.

The most usual, and the greatest strain, to which mate­rials are exposed, is that which tends to break them trans­versely. It is seldom, however, that this is done in a manner perfectly simple ; for when a beam projects horizontally from a wall, and a weight is suspended from its extremity, the beam is commonly broken near the wall, and the intermediate part has performed the functions of a lever. It sometimes, though rarely, happens that the pin in the joint of a pair of pincers or scissors is cut through by the strain ; and this is almost the only case of a simple transverse fracture. Being so rare, we may content our­selves with saying, that in this case the strength of the piece is proportional to the area of the section.

Experiments were made for discovering the resistances made by bodies to this kind of strain in the following man­ner. Two iron bars were disposed horizontally at an inch distance ; a third hung perpendicularly between them, being supported by a pin made of the substance to be examined. This pin was made of a prismatic form, so as to fit exactly the holes in the three bars, which were made very exact, and of the same size and shape. A scale was suspended at the lower end of the perpendicular bar, and loaded till it tore out that part of the pin which filled the middle hole. This weight was evidently the measure of the lateral co­hesion of two sections. The side-bars were made to grasp the middle bar pretty strongly between them, that there might be no distance interposed between the opposite pres­sures. This would have combined the energy of a lever with the purely transverse pressure. For the same reason it was necessary that the internal parts of the holes should be no smaller than the edges. Great irregularities occurred in our first experiments from this cause, because the pins were somewhat tighter within than at the edges ; but when this was corrected they were extremely regular. We employed three sets of holes, viz. a circle, a squire (which was occa­sionally made a rectangle whose length was twice its breadth), and an equilateral triangle. We found in alt our experi­ments the strength exactly proportional to the area of the section, and quite independent of its figure or position, and we found it considerably above the direct cohesion ; that is, it took considerably more than twice the force to tear out this middle piece that it did to tear the pin asunder by a direct pull. A piece of fine freestone required 205 pounds to pull it directly asunder, and 575 to break it in this way. The difference was very constant in any one substance, but varied from four thirds to six thirds in different kinds of matter, being smallest in bodies of a fibrous texture. But indeed we could not make the trial on any bodies of considerable cohe­sion, because they required such forces as our apparatus could not support. Chalk, clay baked in the sun, baked sugar, brick, and freestone, were the strongest that we could examine.

But the more common case, where the energy of a lever intervenes, demands a minute examination. (b. b. b.)

Let ABCD (fig. 3) be the longitudinal section of a beam inserted into a wall at the end AD, and sup­porting a weight at the free end BC : it is required to find what tendency the weight will have to break the beam over at the sec­tion EF.

The weight at C will, in the first place, cause a tendency of the part EBCF to slide down on the surface EF, but the strength of the beam in resisting this kind of dislocation is much greater than its power of resisting common fracture : it is therefore unnecessary to examine this case.

The weight at C will cause the beam to bend ; that is, it will distend the upper and compress the under part of the beam, and, acting at the extremity of the lever FC, its power of causing such compression and distention will be W× FC. Since the weight at C acts in a vertical direction, it cannot tend either to lengthen or to shorten the beam, and thus the repulsion of the compressed part must be exactly equal to the attraction of the distended parts.

Let G be the neutral point, and draw through it the line *fGe,* contiguous to FGE; draw also H*h* and I*i* paral­lel to CD. The lines It, in the under side of the cross sec­tion, will represent the degrees of compression, and also (since within the limits of security the repulsion is propor­tional to the degree of compression) the force of repulsion, while the lines H*h* on the upper side will serve to represent the attractions. The sum of all the lines on the upper side, that is, the wedge EG*c*, will thus represent the entire amount of attraction, while the wedge FG*f* will represent the total amount of repulsion. These two wedges, then, must be equal to each other; and this equality determines the position of the Axis of flexure represented by the point G. In the case of a rectangular beam, G must clearly be in the middle of the line EF ; but when the cross section of the beam is irregular, the position of the axis of flexure is not quite so easily found.

Let EF be the cross section of an irregular beam, and OH the axis of flexure, or the place where the beam is neither compressed nor distended. Then the wedges gene­rated by turning the section EF upon OH as an axis must be equal to each other. This is always the case when OH passes through the centre of gravity of the cross section, and thus it follows that those points which are neither compressed nor distended are always ranged in a straight line drawn through the centre of gravity of the cross section.