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 impoſed 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 or 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 ſquare (which was occaſionally made a rectangle whoſe length was twice its breadth), and an equilateral tri­angle. We found in all 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 than 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 confiant in any one ſubſtance, but varied from 4/3ds to 6/3ds 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.

Let DABC (fig. 5. n⁰ 1.) be a vertical ſection of a priſma­tic ſolid (that is, of equal ſize throughout), projecting hori­zontally from a wall in which it is firmly fixed ; and let a weight P be hung on it at B, or let any power P act at B in a direction perpendicular to AB. Suppoſe the body of inſuperable ſtrength in every part except in the vertical ſec­tion DA, perpendicular to its length. It muſt break in this ſection only. Let the coheſion be uniform over the whole of this ſection ; that is, let each of the adjoining par­ticles of the two parts cohere with an equal force *f.*

There are two ways in which it may break. The part ABCD may ſimply slide down along the ſurface of fracture, provided that the power acting at B is equal to the accu­mulated force which is exerted by every particle of the ſec­tion in the direction AD.

But ſuppoſe this effectually prevented by ſomething that ſupports the point A. The action at P tends to make the body turn round A (or round a horizontal line paſſing thro’ A at right angles to AB) as round a joint. This it can­not do without ſeparating at the line DA. In this caſe the adjoining particles at D or at E will be ſeparated ho­rizontally. But their coheſion reſiſts this ſeparation. In order, therefore, that the fracture may happen, the en­ergy or momentum of the power P, acting by means of the lever AB, muſt be ſuperior to the accumulated energies of the particles. The energy of each depends not only on its coheſive force, but alſo on its ſituation ; for the ſupposed inſuperable firmneſs of the reſt of the body makes it a lever turning round the fulcrum A, and the coheſion of each par­ticle, ſuch as D or E, acts by means of the arm DA or EA. The energy of each particle will therefore be had by multiplying the force exerted by it in the inſtant of fracture by the arm of the lever by which it acts.

Let us therefore firſt ſuppoſe, that in the inſtant of frac­ture every particle is exerting an equal force f*.* The ener­gy of D will be f × DA, and that of E will be f ×EA, and that of the whole will be the ſum of all theſe products. Let the depth DA of the ſection be called d, and let any undetermined part of it EA be called x*,* and then the ſpace occupied by any particle will be *x.* The coheſion of this ſpace may be repreſented by f*x,* and that of the whole by f *d.* The energy by which each element *x* of the line DA, or d*,* reſiſts the fracture, will be *fxx*, and the whole accucumulated energies will be *f* × *fxx.* This we know to be *f* × 1/2*d2,* or fd *× 1/2 d.* It is the ſame therefore as if the co­heſion *fd* of the whole ſection had been acting at the point G, which is in the middle of DA.

The reader who is not familiarly acquainted with this fluxionary calculus may arrive at the ſame conclusion in an­other way. Suppoſe the beam, inſtead of projecting hori­zontally from a wall, to be hanging from the ceiling, in which it is firmly fixed. Let us conſider how the equal co­heſion of every part operates in hindering the lower part from ſeparating from the upper by opening round the joint A. The equal coheſion operates juſt as equal gravity would do, but in the oppoſite direction. Now we know, by the moſt elementary mechanics, that the effect of this will be the ſame as if the whole weight were concentrated in the centre of gravity G of the line DA, and that this point G is in the middle of DA. Now the number of fibres being as the length *d* of the line, and the coheſion of each fibre being = f*,* the coheſion of the whole line is *f × d* or *fd.*

The accumulated energy therefore of the coheſion in the inſtant of fracture is f*d* × 1/2 *d.* Now this muſt be equal or juſt inferior to the energy of the power employed to break it. Let the length AB be called l ; then P × *l* is the correſponding energy of the power. This gives us f*d1/2 d = pl for* the equation of equilibrium correſponding to the verti­cal ſection ADCB.

Suppoſe now that the fracture is not permitted at DA, but at another ſection ςα more remote from B. The body being priſmatic, all the vertical ſections are equal; and there­fore fd1/2*d* is the ſame as before. But the energy of the power is by this means increaſed, being now = P × Bα, inſtead of P × BA : Hence we ſee that when the priſmatic body is not insuperably ſtrong in all its parts, but equally ſtrong throughout, it muſt break cloſe at the wall, where the ſtrain or energy of the power is greateſt. We ſee, too, that a power which is juſt able to break it at the wall is unable to break it anywhere elſe ; alſo an abſolute cohe­ſion f*d,* which can withſtand the power p in the ſection DA, will not withſtand it in the ſection ςα, and will with­ſtand more in the ſection *d' a'.*

This teaches us to diſtinguiſh between abſolute and rela­tive ſtrength. The relative ſtrength of a ſection has a refe­rence to the ſtrain actually exerted on that ſection. This relative ſtrength is properly meaſured by the power which is juſt able to balance or overcome it, when applied at its