to ſtretch the fibres at D, there muſt be some fulcrum, ſome ſupport, on which the virtual lever BAD may preſs, that it may tear aſunder the ſtretched fibres. This fulcrum muſt ſuſtain both the preſſure ariſing from the coheſion of the diſtended fibres, and alſo the action of the external force, which immediately tends to cauſe the prominent part of the beam to slide along the ſection DA. Let BAD (fig. *5.* n⁰ 1.) be conſidered as a crooked lever, of which A is the fulcrum. Let an external force be applied at B in the direction BP, and let a force equal to the accumu­lated coheſion of AD be applied at O in the direction op­poſite to AB, that is, perpendicular to AO ; and let theſe two forces be ſuppoſed to balance each other by the inter­vention of the lever. In the firſt place, the force at O muſt be to the force at B as AB to AO : Therefore, if we make AK equal and oppoſite to AO, and AL equal and oppoſite to AB, the common principles of mechanics inform us that the fulcrum A is affected in the ſame manner as if the two forces AK and AL were immediately applied to it, the force AK being equal to the weight P, and AL equal to the accumulated coheſion actually exerted in the inſtant of fracture. The fulcrum is therefore really preſſed in the direction AM, the diagonal of the parallelogram, and it muſt reſiſt in the direction and with the force MA ; and this power of reſiſtance, this ſupport, muſt be furniſhed by the repulſive forces exerted by *thoſe particles only* which are in a ſtate of actual compreſſion. The force AK, which is equal to the external force P, muſt be refilled in the direc­tion KA by the lateral coheſion of the whole particles between D and A (the particle D is not only drawn forward but downward). This prevents the part CDAB from sliding down along the ſection DA.

This is fully verified by experiment. If we attempt to break a long slip of cork, or any ſuch very compreſſible body, we always obſerve it to bulge out on the concave side before it cracks on the other side. If it is a body of fibrous or foliated texture, it ſeldom fails ſplintering off on the Concave side ; and in many cases this ſplintering is very deep, even reaching half way through the piece. In hard and granulated bodies, ſuch as a piece of freeſtone, chalk, dry clay, ſugar, and the like, we generally ſee a considerable ſplinter or ſhiver fly off from the hollow side. If the frac­ture be ſlowly made by a force at B gradually augmented, the formation of the ſplinter is very diſtinctly ſeen. It forms a triangular piece like aI*b,* which generally breaks in the middle. We doubt not but that attentive obſervation would ſhow that the direction of the crack on each side of I is not very different from the direction AM and its correſpondent on the other side; This is by no means a circumſtance of idle curioſity, but intimately connected with the mechaniſm of coheſion.

Let us ſee what conſequences reſult from this ſtate of the caſe reſpecting the ſtrength of bodies. Let D∆KC (fig. 6.) repreſent a vertical ſection of a priſm of compreſſible mate­rials, ſuch as a piece of timber. Suppoſe it loaded with a weight P hung at its extremity. Suppoſe it of ſuch a constitution that all the fibres in AD are in a ſtate of dilata­tion, while thoſe in Aδ are in a ſtate of compreſſion. In the inſtant of fracture the particles at D and E are withheld by forces D d, E e, and the particles at δ and E repel, resiſt, or ſupport, with forces δδ, Eε.

Some line, ſuch as *deAεδ* will limit all theſe ordinates, which repreſent the forces actually exerted in the inſtant of fracture. If the forces are as the extenſions and compreſsions, as we have great reason to believe, *de*A and Aεδwill be two ſtraight lines. They will form *one* ſtraight line *d*Aδ, if the forces which reſiſt a certain dilatation are equal to the forces which reſiſt an equal compreſſion. But this is quite accidental, and is not ſtrictly true in any body. In moſt bodies which have any considerable firmneſs, the compreſſions made by any external force are not ſo great as the dilatations which the ſame force would produce ; that is, the repulſions which are excited by any ſuppoſed degree of compreſſion are greater than the attractions excited by the ſame degree of dilatation. Hence it will generally follow, that the angle d AD is leſs than the angle δAδ, and the ordinates D d, E e, &c. are leſs than the correſponding or­dinates δδ, Eε, &c.

But whatever be the nature of the line *d*Aδ, we are cer­tain of this, that the whole area AD*d* is equal to the whole area A∆δ : for as the force at B is gradually increaſed, and the parts between A and D are more extended, and greater coheſive forces are excited, there is always ſuch a degree of repulſive forces excited in the particles between A and Δ that the one ſet preciſely balances the other. The force at B, acting perpendicularly to AB, has no tendency to puſh the whole piece cloſer on the part next the wall or to pull it away. The ſum of the attractive and repulſive forces actually excited muſt therefore be equal. Theſe ſums are repreſented by the two triangular areas, which are therefore equal.

The greater we ſuppoſe the repulſive forces correſpond­ing to any degree of compreſſion, in companion with the attractive forces correſponding to the ſame degree of extenſion, the ſmaller will Aδ be in compariſon of AD. In apiece of cork or ſponge, Aδ may chance to be equal to AD, or even to exceed it ; but in a piece of marble, Aδ will perhaps be very ſmall in compariſon of AD.

Now it is evident that the repulſive forces excited be­tween A and δ have no ſhare in preventing the fracture. They rather contribute to it, by furniſhing a fulcrum to the lever, by whoſe energy the coheſion of the particles in AD is overcome. Hence we ſee an important conſequence of the compreſſibility of the body. Its power of refilling this tranſverſe strain is diminiſhed by it, and ſo much the more diminiſhed as the stuff is more compreſſible.

This is fully verified by ſome very curious experiments made by Du Hamel. He took 16 bars of willow 2 feet long and 1/2 an inch ſquare, and ſupporting them by props under the ends, he broke them by weights hung on the middle. He broke 4 of them by weights of 40, 41, 47, and 52 pounds : the mean is 45. He then cut 4 of them 1/3d through on the upper side, and filled up the cut with a thin piece of harder wood ſtuck in pretty tight. Theſe were broken by 48, 54, 50, and 52 pounds ; the mean of which is 51. He cut other four 1/2 through, and they were broken by 47, 49, 50, 46; the mean of which is 48. The remaining four were cut 2/3ds and their mean ſtrength was 42.

A nother ſet of his experiments in ſtill more remarkable.

Six battens of willow 36 inches long and 11/2 ſquare were broken by 525 pounds at a medium.

Six bars were cut 1/3d through, and the cut filled with a wedge of hard wood ſtuck in with a little force: theſe broke with 551.

Six bars were cut half through, and the cut was filled in the ſame manner : they broke with 542.

Six bars were cut 3/4ths through : theſe broke with 530.

A batten cut 3/4ths through, and loaded till nearly broken, was unloaded, and the wedge taken out of the cut. A thicker wedge was put in tight, ſo as to make the batten ſtraight again by filling up the ſpace left by the compresſion of the wood : this batten broke with 577 pounds.

From this it is plain that more than 2/3ds of the thickneſs (perhaps nearly, 3/4ths) contributed nothing to the ſtrength.

The point A is the centre of fracture in this caſe ; and

in order to eſtimate the ſtrength of the piece, we may ſup-