sive forces) to the compreſſion of the under part of the beam ; and we muſt endeavour to explain in what manner this compreſſion produces an effect which ſeems ſo little ex­plicable by ſuch means.

As we have repeatedly obſerved, it is a matter of nearly univerſal experience that the forces *actually* exerted by the particles of bodies, when ſtretched or compreſſed, are very nearly in the proportion of the diſtances to which the par­ticles are drawn from their natural poſitions. Now, altho’ we are certain that, in enormous compreſſions, the forces increaſe faſter than in this proportion, this makes no ſenſible change in the preſent queſtion, becauſe the body is broken before the compreſſions have gone ſo far ; nay, we imagine that the compreſſed parts are crippled in moſt caſes even before the extended parts are torn aſunder. Muſchenbroek aſſerts this with great confidence with reſpect to oak, on the authority of his own experiments. He ſays, that al­though oak will ſuſpend half as much again as fir, it will not ſupport, as a pillar, two-thirds of the load which fir will ſupport in that form.

We imagine therefore that the mechaniſm in the *preſent* case is nearly as follows ;

Let the beam DCK∆ (fig. 23.) be loaded at its extre­mity with the weight P, acting in the direction KP perpen­dicular to DC. Let D∆ be the ſection of fracture. Let DA be about 1/3d of D∆. A will be the particle or fibre which is neither extended nor compreſſed. Make ∆δ; Dd = DA : Aδ. The triangles DA*d,* δAδ, will repreſent the accumulated attracting and repelling forces. Make AI and Ai ≡ 1/3DA and 1/3δA. The point I will be that to which the full coheſion D*d* or *f* of the particles in AD muſt be applied, ſo as to produce the ſame momen­tum which the variable forces at I, D, &c. really produce at their ſeveral points of application. In like manner, *i* is the centre of ſimilar effort of the repulsive forces excited by the compreſſion between A and ∆, and it is the real fulcrum of a bended lever I*i*K, by which the whole effect is produ­ced. The effect is the ſame as if the full coheſion of the ſtretched fibres in AD were accumulated in I, and the full repulsion of all the compreſſed fibres in A∆ were accumu­lated in *i.* The forces which are balanced in the operation are the weight P, acting by the arm *ki,* and the full cohe­ſion of AD acting by the arm I*i.* The forces exerted by the compreſſed fibres between A and ∆ only ſerve to give ſupport to the lever, that it may exert its ſtrain.

We imagine that this does not differ much from the real procedure of nature. The position of the point A may be different from what we have deduced from Mr Buffon’s ex­periments, compared with Muſchenbroek’s value of the absolute cohesion of a ſquare inch. If this laſt ſhould be only 12000, DA muſt be greater than we have here made it, in the proportion of 12000 to 16000. For I*i* muſt ſtill be made = 1/3A∆, ſupposing the forces to be propor­tional to the extensions and compreſſions. There can be no doubt that a part only of the coheſion of D∆ operates in refilling the fracture in all ſubſtances which have any compreſſibility ; and it is confirmed by the experiments of Mr Du Hamel on willow, and the inferences are by no means confined to that ſpecies of timber. We ſay therefore, that when the beam is broken, the coheſion of AD alone is exerted, and that each fibre exerts a force proportional to its extension ; and the accumulated momentum is the ſame as if the full coheſion of AD were acting by the lever I*i* ≡ 1/3d of Dδ .

It may be said, that if only 1/3d of the coheſion of oak be exerted, it may be cut 2/3ds through without weakening it. But this cannot be, becauſe the coheſion of the whole is em­ployed *in* preventing the lateral slide ſo often mentioned. We have no experiments to determine that it *may not* be cut through 1/3d without loss of its ſtrength.

This muſt not be conſidered as a ſubject of mere ſpeculative curiosity : It is intimately connected with all the prac­tical uſes which we can make of this knowledge ; for it is almoſt the only way that we can learn the compreſſibilſty of timber. Experiments on the direct coheſion are indeed difficult, and exceedingly expensive if we attempt them in large pieces. But experiments on compreſſion are almoſt impracticable. The moſt inſtructive experiments would be, firſt to eſtabliſh, by a great number of trials, the tranſverſe force of a modern batten ; and then to make a great number of trials of the diminution of its ſtrength, by cutting it through on the concave side. This would very nearly give us the proportion of the coheſion which really operates in refitting fractures. Thus if it be found that one-half of the beam may be cut on the under side without diminution of its ſtrength (taking care to drive in a ſlice of harder wood), we may conclude that the point A is at the middle, or ſomewhat above it.

Much lies before the curious mechanician, and we are as yet very far from a ſcientific knowledge of the ſtrength of timber.

In the mean time, we may derive from theſe experiments of Buffon a very uſeful practical rule, without relying on any value of the abſolute coheſion of oak. We ſee that the ſtrength is nearly as the breadth, as the ſquare of the depth, and as the inverse of the length. It is moſt convenient to meaſure the breadth and depth of the beam in inches, and its length in feet. Since, then, a beam four inches ſquare and ſeven feet between the ſupports is broken by 5312 pounds, we muſt conclude that a batten one inch ſquare and one foot between the ſupports will be broken by 581 pounds. Then the ſtrength of any other beam of oak, or the weight which will juſt break it when hung on its middle, *bd2*

is 581(bd2/l).

But we have ſeen that there is a very considerable devia­tion from the inverſe proportion of the lengths, and we muſt endeavour to accommodate our rule to this deviation. We found, that by adding 1245 to each of the ordinates or numbers in the column of the five-inch bars, we had a ſet of numbers very nearly reciprocal of the lengths ; and if we make a ſimilar addition to the other columns in the propor­tion of the cubes of the fixes, we have nearly the ſame reſult. The greateſt error (except in the caſe of experiments which are very irregular) does not exceed 1/15th of the whole. Therefore, for a radical number, add to the 5312 the num­ber 640, which is to 1245 very nearly as 43 to 53. This gives 5952. The 64th of this is 93, which correſponds to a bar of one inch ſquare and ſeven feet long. Therefore 93 × 7 will be the reciprocal corresponding to a bar of one foot. This is 651. Take from this the preſent empirical correction, which is *b*40/b4, or 10, and there remains 641 for the ſtrength of the bar. This gives us for a general rule p = 651(bd2)/l - 10bd2.

*Example.* Required the weight neceſſary to break an oak beam eight inches ſquare and 20 feet between the props, p *=* 651 × (8 *×* 82)/20 - (10 *× 8 × 8*2*).* This is 11545, whereas the experiment gives 11487. The error is very ſmall indeed. The rule is moſt deficient in compariſon with the five-inch bars, which we have already ſaid appear ſtrong­er than the reſt.