union ; and therefore thoſe which are ſtronger will not aſſiſt their weaker neighbours. To this we must add, that in the ſhorter beams the force with which the fibres are preſſed la­terally on each other is double. This must impede the mu­tual sliding of the fibres which we mentioned a little ago; nay, this lateral compreſſion may change the law of longitudinal coheſion (as will readily appear to the reader who is ac­quainted with Boſcovich’s doctrines), and increaſe the strength of the very ſurface of fracture, in the ſame way (however inexplicable) as it does in metals when they are hammered or drawn into wire.

The reader must judge how far theſe remarks are worthy of his attention. The engineer will carefully keep in mind the important fact, that a beam of quadruple length, instead of having 1/4th of the strength, has only about 1/6th ; and the philoſopher ſhould endeavour to diſcover the cauſe of this diminution, that he may give the artist a more accurate rule of computation.

Our ignorance of the law by which the coheſion of the particles changes by a change of distance, hinders us from diſcovering the preciſe relation between the curvature and the momentum of coheſion ; and all we can do is to multiply experiments, upon which we may establiſh ſome *empirical* rules for calculating the strength of ſolids. Thoſe from which we must reaſon at preſent are few and too ano­malous to be the foundation of ſuch an empirical formula. We may, however, obſerve, that Mr Buffon’s experiments give us considerable aſſistance in this particular : For if to each of the numbers of the column for the 5-inch beams, corrected by adding half the weight of the beam, we add the constant number 1245, we ſhall have a ſet of numbers which are very nearly reciprocals of the lengths. Let 1245 be called c*,* and let the weight which is known by experiment to be neceſſary for breaking the 5-inch beam of the length *a* be called P. We ſhall have ((P + c) *× a)/l - c = p.* Thus the weight neceſſary for breaking the 7-foot bar is 11560. This added to 1245, and the ſum multiplied by 7, gives (P + *c) × a ≡ 89635.* Let l be 18 ; then 89635/18 - 1245 = 3725, = p, which differs not more than 1/40th from what experiment gives us. This rule holds equally well in all the other lengths except the 10 and 24 foot beams, which are very anomalous. Such a formula is abun­dantly exact for practice, and will anſwer through a much greater variety of length, though it cannot be admitted as a true one ; becauſe, in a certain very great length, the strength will be nothing. For other ſizes the constant number must change in the proportion of *d3*, or perhaps of *p.*

The next companion which we have to make with the theory is the relation between the strength and the ſquare of the depth of the ſection. This is made by comparing with each other the numbers in any horizontal line of the table. In making this compariſon we find the numbers of the five-inch bars uniformly greater than the rest. We imagine that there is ſomething peculiar to theſe bars : They are in general heavier than in the proportion of their ſection, but not ſo much ſo as to account for all their ſuperiority. We imagine that this ſet of experiments, intended as a standard for the rest, has been made at one time, and that the ſeaſon has had a conſiderable influence. The fact however is, that if this column be kept out; or uniformly diminiſhed about 1/16th in their strength, the different ſizes will deviate very little from the ratio of the ſquare of the depth, as determined by theory. There is however a ſmall deficiency in the bigger beams.

We have been thus anxious in the examination of theſe experiments, becauſe they are the only ones which have been related in sufficient detail, and made on a proper ſcale for giving us data from which we can deduce confidential maxims for practice. They are ſo troublesome and expenſive that we have little hopes of ſeeing their number greatly increaſed ; yet ſurely our navy board would do an unſpeakable ſervice to the public by appropriating a fund for ſuch experiments under the management of ſome man of ſcience.

There remains another compariſon which is of chief im­portance, namely, the proportion between the absolute cohesion and the relative strength. It may be guessed, from the very nature of the thing, that this must be very uncertain. Experiments on the abſolute strength must be confined to very ſmall pieces, by reaſon of the very great forces which are required for tearing them aſunder. The values therefore deduced from them must be ſubject to great inequalities. Unfortunately we have got no detail of any experiments ; all that we have to depend on is two paſſages of Muſchenbroek’s *Eſſais de Phyſique ;* in one of which he lays that a piece of sound oak 27/100ths of an inch square is torn aſunder by 1150 pounds ; and in the other, that an oak plank 12 inches broad and 1 thick will juſt ſuſpend 189163 pounds. Theſe give for the coheſion of an inch ſquare 15,755 and 15,763 pounds. Bouguer, in his *Traité du Navire,* ſays that it is very well known that a rod of sound oak 1/4th of an inch ſquare will be torn aſunder by 1000 pounds. This gives 16000 for the coheſion of a ſquare inch. We ſhall take this as a round number, eaſily uſed in our computations. Let us compare this with Mr Buffon’s trials of beams four inches ſquare.

The abſolute coheſion of this ſection is 16,000 × 16 = 256,000. Did every fibre exert its whole force in the in­stant of fracture, the momentum of coheſion would be the ſame as if it had all acted at the centre of gravity of the ſection at 2 inches from the axis of fracture, and is therefore 512000. The 4-inch beam, 7 feet long, was broken by 5312 pounds hung on its middle. The half of this, or 2656 pounds, would have broken it, if ſuſpended at its ex­tremity, projecting 3 1/2 ſect or 42 inches from a wall. The momentum of this strain is therefore 2656 × 42, = 111552. Now this is in equilibrio with the actual momentum of cohesion, which is therefore 111552, instead of 512000. The strength is therefore diminiſhed in the proportion of 512000 to 111552, or very nearly of 4,59 to 1.

As we are quite uncertain as to the place of the centre of effort, it is needleſs to conſider the full coheſion as acting at the centre of gravity, and producing the momentum 512,000 ; and we may convert the whole into a simple multiplyer *m* of the length, and say, *as* m *times the length is to the depth, ſo is the abſolute coheſion of the ſection to the re­lative strength.* Therefore let the abſolute coheſion of a ſquare inch be called f*,* the breadth *b,* the depth *d,* and the length *l* (all in inches), the relative strength, or the exter­nal force *p,* which balances it, is fbd2/9,181,or in round numbers fbd2/9l; for m = 2 *× 4,59.*

This great diminution of strength cannot be wholly ac­counted for by the inequality of the coheſive forces exerted in the inſtant of fracture ; for in this caſe we know that the centre of effort is at 1/3d of the height in a rectangular section (becauſe the forces really exerted are as the extenſions of the fibres). The relative strength would be fbd2/3l, and p would have been 8127 instead of 2656.

We must aſcribe this diminution (which is three times greater than that produced by the inequality of the cohe-