is neither stretched nor compressed, must now be farther up, or nearer to D ; and therefore the number of particles which are exerting cohesive forces is smaller, and therefore the strength is diminished. Therefore, when we endeavour to proportion the strength of a beam to the strain arising from an external force acting obliquely, we make too liberal allowance by increasing this external force in the ratio of AB to AB'. We acknowledge our inability to assign the proper correction. But this circumstance is of very great influence. In many machines, and many framings of car­pentry, this oblique action of the straining force is unavoid­able ; and the most enormous strains to which materials are exposed are generally of this kind. In the frames set up for carrying the ringstones of arches, it is hardly possible to avoid them ; for although the judicious engineer dispose his beams so as to sustain only pressures in the direction of their lengths, tending either to crush them or to tear them asunder, it frequently happens that, by the settling of the work, the pieces come to check and. bear on each other transversely, tending to break each other across. This we have remarked upon in the article Roof, with respect to a truss by Mr Price (see Roof, p. 452-54). Now when a cross strain is thus combined with an enormous pressure in the direction of the length of the beam, it is in the utmost dan­ger of snapping suddenly across. This is one great cause of the carrying away of masts. They are compressed in the direction of their length by the united force of the shrouds, and in this state the transverse action of the wind soon completes the fracture.

When considering the compressing strains to which ma­terials are exposed, we deferred the discussion of the strain on columns, observing that it was not, in the cases which usually occur, a simple compression, but was combined with a transverse strain, arising from the bending of the column. When the column ACB (fig. 17), resting on tl∣e ground at B, and loaded at top with a weight A, acting in the vertical direction AB, is bent into a curve ACB, so that the tangent at C is perpendi­cular to the horizon, its condition somewhat resembles that of a beam firmly fixed between B and C, and strongly pulled by the end A, so as to bend it between C and A. Although we cannot conceive how a force acting on a straight column AB in the direction AB can bend it, we may suppose that the force acted first in the horizontal direction Aft till it was bent to this degree, and that the rope was then gra­dually removed from the direction Aft to the direction AB, increasing the force as much as is necessary for preserving the same quantity of flexure.

The first author, we believe, who considered this im­portant subject with scrupulous attention was the celebrated Euler, who published in the Berlin Memoirs for 1757 his Theory of the Strength of Columns. The general propo­sition established by this theory is, that the strength of prismatical columns is in the direct quadruplicate ratio of their diameters, and the inverse duplicate ratio of their lengths. he prosecuted this subject in the Petersburg Commentaries for 1778, confirming his former theory. We do not find that any other author has bestowed much at­tention on it, all seeming to acquiesce in the determinations of Euler, and to consider the subject as of very great diffi­culty, requiring the application of the most refined mathe­matics. Muschenbroeck has compared the theory with ex­periment; but the comparison has been very unsatisfactory, the difference from the theory being so enormous as to af­ford no argument for its justness. But the experiments do not contradict it, for they are so anomalous as to afford no conclusion or general rule whatever.

To say the truth, the theory can be considered in no

other light than as a specimen of ingenious and very artfill algebraic analysis. Euler was unquestionably the first analyst in Europe for resource and address. He knew this, and enjoyed his superiority, and without scruple ad­mitted any physical assumptions which gave him an op­portunity of displaying his skill. The inconsistency of his assumptions with the known laws of mechanism gave him no concern ; and when his algebraic processes led him to any conclusion which would make his readers stare, being contrary to all our usual notions, he frankly owned the paradox, but went on in his analysis, saying, *Sed analyst magis fidendum.* Mr Robins has given some very risible instances of this confidence in his analysis, or rather of his confidence in the indolent submission of his readers. Nay, so fond was he of this kind of amusement, that after hav­ing published an untenable Theory of Light and Colours, he published several Memoirs, explaining the aberration of the heavenly bodies, deducing some very wonderful con­sequences, fully confirmed by experience, from the New­tonian principles, which were opposite and totally incon­sistent with his own theory, merely because the Newtonian theory gave him *occasionem analyseos promovenda·.* We are thus severe in our observations, because his Theory of the Strength of Columns is one of the strongest instances of this wanton kind of proceeding, and because his followers in the Academy of St Petersburg, such as Fuss, Lexill, and others, adopt his conclusions, and merely echo his words. Since the death of Daniel Bernoulli, no member of that academy has controverted any thing advanced by their *Professor sublimis Geometrice,* to whom they had been indebted for their places and for all their knowledge, hav­ing been (most of them) his amanuenses, employed by this wonderful man during his blindness, to make his computa­tions and carry on his algebraic investigations. We are not a little surprised to see Mr Emerson, a considerable mathe­matician, and a man of very independent spirit, hastily adopting the same theory, of which we doubt not but our readers will easily see the falsity.

Euler considers the column ACB as in a condition pre­cisely similar to that of an elastic rod bent into the curve by a cord AB connecting its extremities. In this he is not mistaken. But he then draws CD perpendicudar to AB, and considers the strain on the section C as equal to the momentum or mechanical energy of the weight A, act­ing in the direction DE, upon the lever *kc*D, moveable round the fulcrum *c,* and tending to tear asunder the par­ticles which cohere along the section *c*C*k.* This is the same principle (as Euler admits) employed by James Ber­noulli in his investigation of the elastic curve ACB. Euler considers the strain on the section *ck* as the same with what it would sustain if the same power acted in the horizontal direction EF on a point E, as far removed from C as the point D is. We reasoned in the same manner (as has been observed) in the article Roof, where the obliquity of ac­tion was inconsiderable. But in the present case this sub­stitution leads to the greatest mistakes, and has render­ed the whole of this theory false and useless. It would be just if the column were of materials which are incompres­sible. But it is evident, by what has been said above, that by the compression of the parts the real fulcrum of the lever shifts away from the point *c*, so much the more as the com­pression is greater. In the great compressions of loaded columns, and the almost unmeasurable compressions of the truss-beams in the centres of bridges, and other cases of chief importance, the fulcrum is shifted far over towards *k,* so that very few fibres resist the fracture by their cohesion, and these few have a very feeble energy or momentum, on account of the short arm of the lever by which they act. This is a most important consideration in carpentry, yet makes no element of Euler’s theory. The consequence of this is, that a very small degree of curvature is sufficient