wall or at the fulcrum. They are not, however, equally ſtiff. The firſt, repreſented in fig. 15. will bend leaſt upon the whole, and the one formed by the cubic parabola will bend moſt. But their curvature at the very fulcrum will be the ſame in all.

It is also plain, that if the lever is of the ſecond or third kind, that is, having the fulcrum at one extremity, it muſt ſtill be of the ſame ſhape ; for in abſtract mechanics it is indifferent which of the three points is conſidered as the axis of motion. In every lever the two forces at the extre­mities act in one direction, and the force in the middle acts in the oppoſite direction, and the great ſtrain is always at that point. Therefore a lever ſuch as fig. 15. moveable round an axis paſſing horizontally through λ, and acting againſt an obſtacle at OP, is equally able in all its parts to refill the strains excited in thoſe parts.

The ſame principles and the ſame conſtruction will apply **to** beams, ſuch as joiſts, ſupported at the ends L and λ (fig. 15.), and loaded at ſome intermediate part OP. This will appear evident by merely inverting the directions of the forces at theſe three points, or by recurring to the article Roofs, n⁰ 19.

Hitherto we have ſuppoſed the external ſtraining force as acting only in one point of the beam. But it may be uni­formly diſtributed all over the beam. To make a beam in ſuch circumſtances equally ſtrong in all its parts, the ſhape muſt be conſiderably different from the former.

Thus ſuppoſe the beam to project from a wall.

If it be of equal breadth throughout, its sides being verti­cal planes parallel to each other and to the length, the ver­tical ſection in the direction of its length muſt be a triangle inſtead of a common parabola ; for the weight uniformly diſtributed over the part lying beyond any ſection, is as the length beyond that ſection : and ſince it may all be con­ceived as collected at its centre of gravity, which is the middle of that length, the lever by which this load acts or ſtrains the ſection is alſo proportional to the ſame length. The ſtrain on the ſection (or momentum of the load) is as the ſquare of that length. The ſection muſt have ſtrength in the ſame proportion. Its ſtrength being as the breadth and the ſquare of the depth, and the breadth being conſtant, the ſquare of the depth of any ſection muſt be as the ſquare of its diſtance from the end, and the depth muſt be as that di­ſtance ; and therefore the longitudinal vertical ſection muſt be a triangle.

But if all the tranſverſe ſections are circles, ſquares, or **any** other ſimilar figures, the ſtrength of every ſection, or the cube of the diameter, muſt be as the ſquare of the lengths beyond that ſection, or the ſquare of its diſtance from the end ; and the sides of the beam muſt be a semicubical parabola.

If the upper and under ſurfaces are horizontal planes, it is evident that the breadth muſt be as the ſquare of the di­ſtance from the end, and the horizontal sections may be form­**ed** by arches of the common parabola, having the length for their tangent at the vertex.

By recurring to the analogy ſo often quoted between a projecting beam and a joiſt, we may determine the proper form of joiſts which are uniformly loaded through their whole length.

This is a frequent and important case, being the office of joiſts, rafters, &c. and there are ſome circumſtances which muſt be particularly noticed, becauſe they are not so obvi­ous, and have been miſunderſtood. When a beam AB (fig. 17.) is ſupported at the ends, and a weight is laid on any point P, a ſtrain is excited in every part of the beam. The load on P causes the beam to press on A and B, and the props react with forces equal and oppoſite to theſe preſſures. The load at P is to the preſſures at A and B as AB to PB and PA, and the preſſures at A is to that at B as PB to PA ; the beam therefore is in the ſame ſtate, with reſpect to ſtrain in every part of it, as if it were reſting on a prop at P, and were loaded at the ends with weights equal to the two preſsures on the props : and obſerve, theſe preſſures are ſuch as will balance each other, being inversely as their diſtances from P. Let P repreſent the weight or load at P. The preſſure on the prop P muſt PA

be P × PA/AB. This is therefore the reaction of the prop B,and is the weight which we may ſuppoſe ſuſpended at B, when we conceive the beam reſting on a prop at P, and carrying the balancing weights at A and B.

The ſtrain occaſioned at any other point C, by the lead P at P, is the ſame with the ſtrain at C, by the weight PA

P × PA/AB hanging at B, when the beam reſts on P, in the manner now ſuppoſed ; and it is the ſame if the beam, in­ſtead of being balanced on a prop at P, had its part AP fixed in a wall. This is evident. Now we have ſhown at PA

length that the ſtrain at C, by the weight P × PA/AB hanging at B, is P × PA/AB × BC. We deſire it to be particularly remarked that the preſſure at A has no influence on the ſtrain at C, ariſing from the action of any load between A and C ; for it is indifferent how the part AP of the projec­ting beam PB is ſupported. The weight at A juſt per­forms the ſame office with the wall in which we ſuppoſe the beam to be fixed. We are thus particular, becauſe we have ſeen even perſons not unaccuſtomed to diſcussions of this kind puzzled in their conceptions of this ſtrain.

Now let the load P be laid on ſome point p between C and B. The ſame reaſoning ſhows us that the point is (with reſpect to ſtrain) in the same ſtate as if the beam were fixed in a wall, embracing tire part pB, and a weight = P × pB/AB were hung on at A, and the ſtrain at C is P × pB/AB × AC.

In general, therefore, the ſtrain on any point C, ariſing from a load P laid on another point P, is proportional to the rectangle of the diſtances of P and C from the ends neareſt to each. It is P × (PA × CB)/AB, or P ×(pB × CA)/AB,

according as the load lies between C and A or between C and B.

*Cor.* 1. The ſtrains which a load on any point P occaſions on the points C, c, lying on the ſame side of P, are as the diſtances of theſe points from the end B. In like man­ner the ſtrains on E and *e* are as EA and *e*A.

*Cor.* 2. The ſtrain which a load occaſions in the part on which it reſts is as the rectangle of the parts on each side. Thus the ſtrain occaſioned at C by a load is to that at D by the ſame load as AC × CB to AD × DB. It is there­fore greateſt in the middle.

Let us now conſider the ſtrain on any point C ariſing from a load uniformly diſtributed along the beam. Let AP be repreſented by *x,* and Pp by *x,* and the whole weight on the beam by *a.* Then

The weight on P *p* is = a(x/AB),

Preſſure on B by the weight on Pp = a(x/AB) × a/AB.