the greater will be the curvature which the beam will ac­quire before it breaks. Greater depth therefore makes a beam not only ſtronger but alſo ſtiffer. But if the parallel fibres can slide on each other, both the ſtrength and the ſtiffneſs will be diminiſhed. Therefore if, inſtead of one beam D∆KC, we ſuppoſe two, DABC and A∆KB, not cohering, each of them will bend, and the extenſion of the fibres AB of the under beam will not hinder the compreſ­ſion of the adjoining fibres AB of the upper beam. The two together therefore will not be more than twice as ſtrong as one *of* them (ſuppoſing DA = A∆) inſtead of being four times as ſtrong ; and they will bend as much as either of them alone would bend by half the load. This may be prevented, if it were poſſible to unite the two beams all along the ſeam AB, ſo that the one ſhall not slide on the other. This may be done in ſmall works, by gluing them together with a cement as ſtrong as the natural lateral co­heſion of the fibres. If this cannot be done (as it cannot in large works), the sliding is prevented by joggling the beams together ; that is, by cutting down ſeveral rectangu­lar notches in the upper side of the lower beam, and making ſimilar notches in the under side of the upper beam, and filling up the ſquare ſpaces with pieces of very hard wood firmly driven in, as repreſented in fig. 9. Some employ iron bolts by way of joggles. But when the joggle is much harder than the wood into which it is driven, it is very apt to work loose, by widening the hole into which it is lod­ged. The ſame thing is ſometimes done by ſcarfing the one upon the other, as repreſented in fig. 9. (n⁰ 2.); but this waſtes more timber, and is not ſo ſtrong, becauſe the mutual hooks which this method forms on each beam are very apt to tear each other up. By one or other of theſe methods, or ſomething ſimilar, may a compound beam be formed, of any depth, which will be almoſt as ſtiff and ſtrong as an entire piece.

On the other hand, we may combine ſtrength with pliableneſs, by compoſing our beam of ſeveral thin planks laid on each other, till they make a proper depth, and leaving them at full liberty to slide on each other. It is in this manner that coach-springs are formed, as is repreſented in fig. 10. In this assemblage there muſt be no joggles nor bolts of any kind put through the planks or plates ; for this would hinder their mutual sliding. They muſt be kept together by ſtraps which ſurround them, or by ſomething equivalent.

The preceding obſervations ſhow the propriety of ſome maxims of conſtruction, which the artiſts have derived from long experience.

Thus, if a mortiſe is to be cut out of a piece which is expoſed to a croſs ſtrain, it ſhould be cut out from that side which becomes concave by the ſtrain, as in fig. 11. but by no means as in fig. 12.

If a piece is to be ſtrengthened by the addition of ano­ther, the added piece muſt be joined to the side which grows convex by the ſtrain, as in fig. 13. and 14.

Before we go any farther, it will be convenient to recal the reader’s attention to the analogy between the ſtrain on a beam projecting from a wall and loaded at the extremity, and a beam ſupported at both ends and loaded in ſome in­termediate point. It is ſufficient on this occasion to read attentively what is delivered in the article Roof, n⁰ 19. We learn there that the ſtrain on the middle point C (fig. 14. of the preſent article) of a rectangular beam AB, sup­ported on props at A and B, is the ſame as if the part CA projected from a wall, and were loaded with the half of the weight W ſuſpended at A. The momentum of the ſtrain pl is therefore 1/2W × 1/2AB, = W × 1/4AB = p1/4l, or pl/4.

The momentum of coheſion muſt be equal to this in every hypotheſis.

Having now conſidered in ſufficient detail the circumſtances which affect the ſtrength of any ſection of a ſolid body that is strained tranſverſely, it is neceſſary to take no­tice of ſome of the chief modifications of the ſtrain itſelf. We ſhall conſider only thoſe that occur moſt frequently in our conſtructions.

The ſtrain depends on the external force, and alſo on the lever by which it acts.

It is evidently of importance, that ſince the ſtrain is exerted in any ſection by means of the coheſion of the parts intervening between the ſection under conſideration and the point of application of the external force, the body muſt be able in all theſe intervening parts to propagate or excite the ſtrain in the remote ſection. In every part it muſt be able to reſiſt the ſtrain excited in that part. It ſhould therefore be equally ſtrong; and it is uſeleſs to have any part ſtrong­er, becauſe the piece will nevertheleſs break where it is not ſtronger throughout ; and it is uſeleſs to make it ſtronger (relatively to its ſtrain) in any part, for it will nevertheleſs equally fail in the part that is too weak.

Suppoſe then, in the firſt place, that the ſtrain ariſes from a weight ſuſpended at one extremity, while the other end is firmly fixed in a wall. Supposing alſo the croſs ſec­tions to be all rectangular, there are ſeveral ways of ſhaping the beam ſo that it ſhall be equally ſtrong throughout. Thus it may be equally deep in every part, the upper and under ſurfaces being horizontal planes. The condition will be fulfilled by making all the horizontal ſections triangles, as in fig. 15. The two sides are vertical planes meeting in an edge at the extremity L. For the equation expreſſing the balance of ſtrain and ſtrength is pl = fbd2*.* Therefore since *d2* is the ſame throughout, and also p, we muſt have fb *= l,* and *b* (the breadth AD of any ſection ABCD) muſt be proportional to l (or AL), which it evidently is.

Or, if the beam be of uniform breadth, we muſt have *d2* everywhere proportional to l. This will be obtained by making the depths the ordinates of a common parabola, of which L is the vertex and the length is the axis. The upper or under side may be a ſtraight line, as in fig. 16. or the middle line may be ſtraight, and then both upper and under ſurfaces will be curved. It is almoſt indifferent what is the ſhape of the upper and under ſurfaces, provided the diſtances between them in every part be as the ordinates of a common parabola.

Or, if the ſections are all ſimilar, ſuch as circles, squares, or any other ſimilar polygons, we muſt have *d3* Or *b*3 pro­portional to l, and the depths or breadths muſt be as the or­dinates of a cubical parabola.

It is evident that theſe are alſo the proper forms for a lever moveable round a fulcrum, and acted on by a force at the extremity. The force comes in the place of the weight ſuſpended in the cases already conſidered ; and as ſuch levers always are connected with another arm, we readily see that both arms ſhould be faſhioned in the ſame manner. Thus in fig. 15. the piece of timber may be supposed a kind of steelyard, moveable round a horizontal axis. OP, in the front of the wall, and having the two weights P and π in equili­brio. The ſtrain occaſioned by each at the ſection in which the axis OP is placed muſt be the ſame, and each arm OL and Ολ muſt be equally ſtrong in all its parts. The lon­gitudinal ſections of each arm muſt be a triangle, a common parabola, or a cubic parabola, according to the conditions previouſly given.

And, moreover, all theſe forms are equally ſtrong : For any one of them is equally ſtrong in all its parts, and they are all ſuppoſed to have the ſame ſection at the front of the