|  |  |  |
| --- | --- | --- |
| Steel, bar.... | Soft | 120,000 |
| Razor temper | 150,000 |
|  | Malacca | 3,100 |
|  | Banca | 3,600 |
| Tin, cast..... | Block | 3,800 |
|  | English block | 5,200 |
|  | — grain | 6,500 |
| Lead, cast |  | 860 |
| Regulus of antimony | | 1,000 |
| Zinc |  | 2,600 |
| Bismuth |  | 2,900 |

It is very remarkable, that almost all the mixtures of me­tals are more tenacious than the metals themselves. The change of tenacity depends much on the proportion of the ingredients, and the proportion which produces the most tenacious mixture is different in the different metals. We have selected the following from the experiments of Muschenbroeck. The proportion of ingredients here selected is that which produces the greatest strength.

Two parts of gold with one of silver 28,000

Five parts of gold with one of copper .50,000

Five parts of silver with one of copper 48,500

Four parts of silver with one of tin 41,000

Six parts of copper with one of tin 41,000

Five parts of Japan copper with one of Banca tin...57,000 Six parts of Chili copper with one of Malacca tin...60,000 Six parts of Swedish copper with one of Malacca tin 64,000 Brass consists of copper and zinc in an unknown pro­

portion ; its strength is 51,000

Three parts of block-tin with one part of lead 10,200

Eight parts of block-tin with one part of zinc 10,000

Four parts of Malacca tin with one part of regulus

of antimony 12,000

Eight parts of lead with one of zinc 4,500

Four parts of tin with one of lead and one of zinc... 13,000

These numbers are of considerable use in the arts. The mixtures of copper and tin are particularly interesting in the fabric of great guns. We see that, by mixing copper, whose greatest strength does not exceed 37,000, with tin, which does not exceed 6000, we produce a metal whose tenacity is almost double, at the same time that it is harder and more easily wrought. It is, however, more fusible, which is a great inconvenience. We also see that a very small addition of zinc almost doubles the tenacity of tin, and increases the tenacity of lead five times ; and a small addition of lead doubles the tenacity of tin. These are economical mixtures. This is very valuable information to the plumbers, for augmenting the strength of water-pipes.

By having recourse to these tables, the engineer can proportion the thickness of his pipes, of whatever metal, to the pressures to which they are exposed.

2*d,* *Woods.*

We may premise to this part of the table the following general observations.

1. The wood immediately surrounding the pith or heart of the tree is the weakest, and its inferiority is so much more remarkable as the tree is older. In this assertion, however, we speak with some hesitation. Muschenbroeck’s *detail* of experiments is decidedly in the affirmative. Μ. Buffon, on the other hand, says that his experience has taught him that the heart of a sound tree is the strongest ; but he gives no instances. From many observations of our own on very *large* oaks and firs, we are certain that the heart is much weaker than the exterior parts.

2. The wood next the bark, commonly called the *white* or *blea,* is also weaker than the rest ; and the wood gra­dually increases in strength as we recede from the centre to the blea.

3. The wood is stronger in the middle of the trunk than at the springing of the branches or at the root ; and the wood of the branches is weaker than that of the trunk.

4. The wood of the north side of all trees which grow in our European climates is the weakest, and that of the south­east side is the strongest ; and the difference is most re­markable in hedge-row trees, and such as grow singly. The heart of a tree is never in its centre, but always nearer to the north side, and the annual coats of wood are thinner on that side. In conformity with this, it is a general opinion of carpenters that timber is stronger whose annual plates are thicker. The trachea or air-vessels are weaker than the simple ligneous fibres. The air-vessels are the same in diameter and number of rows in trees of the same spe­cies, and they make the visible separation between the annual plates. Therefore, when these are thicker, they contain a greater proportion of the simple ligneous fibres.

5. All woods are more tenacious while green, and lose very considerably by drying after the trees are felled.

The only author who has put it in our power to judge of the propriety of his experiments is Muschenbroeck. He has described his method of trial minutely, and it seems unexceptionable. The woods were all formed into slips fit for his apparatus, and part of the slip was cut away to a parallelopiped of 1/5th of an inch square, and therefore 1/5th of a square inch in section. The absolute strengths of a square inch were as follow :

|  |  |  |  |
| --- | --- | --- | --- |
| lib. | | | lib.  9750  9250 |
| Locust tree  Juleb | 20,100  18,500 | Pomegranate  Lemon |
| Beech, oak | 17,300 | Tamarind | 8750 |
| Orange | 15,500 | Fir | 8330 |
| Alder | 13,900 | Walnut | 8130 |
| Elm | 13,200 | Pitch-pine | 7650 |
| Mulberry | .....12,500 | Quince | 6750 |
| Willow | 12,500 | Cvpress | 6000 |
| Ash | 12,000 | Poplar | 5500 |
| Plum | 11,800 | Cedar , | 4880 |
| Elder | 10,000 |  |  |

Muschenbroeck has given a very minute detail of the experiments on the ash and tile walnut, stating the weights which were required to tear asunder slips taken from thc four sides of the tree, and on each side, in a regular pro­gression from the centre to the circumference. The num­ber of this table corresponding to these two timbers may therefore be considered as the average of more than fifty trials made of each ; and he says that all the others were made with the same care. We cannot therefore see any reason for not confiding in the results ; yet they are con­siderably higher than those given by some other writers. Mr Pitot, on the authority of his own experiments, and of those of Mr Parent, avers that sixty pounds will just tear asunder a square line of sound oak, and that it will bear fifty with safety. This gives 8640 for the utmost strength of a square inch, which is much inferior to Muschenbroeck’s valuation.

We may add to these,

Ivory 16,270

Bone 5,250

Hom 8,750

Whalebone 7,500

Tooth of sea-calf. 4,075

The reader will surely observe, that these numbers ex­press something more than the utmost cohesion ; for the weights are such as will very quickly, that is, in a minute or two, tear the rods asunder. It may be said in general, that two thirds of these weights will sensibly impair the strength after a considerable while, and that one half is the utmost that can remain suspended at them without risk for ever ; and it is upon this last allotment that the engineer should reckon in his constructions. There is, however, con­siderable difference in this respect. Woods of a very straight