which an Engine usually does, is *Duty;* but as this word naturally signifies what the engine *ought* to do, rather than what it does, we should at least distinguish between the Theoretical and the Actual Duty.

The difference between the Theoretical and Actual Duty of a Machine arises from this: that a portion of the Laboring Force is absorbed in producing effects, that is, in doing work which is not reckoned as Duty: for instance, overcoming the resistance and waste of the machine itself. And so long as this resistance and waste are not rightly estimated, no correspondence can be established between the theoretical and the practical Duty. Though much had been written previously upon the theory of the steam-engine, the correspondence between the Force expended and the Work done was not clearly made out till Comte De Pambour published his *Treatise on Locomotive Engines* in 1835, and his *Theory of the Steam-Engine* in 1839.

Strength of Materials.

Among the subjects which have specially engaged the attention of those who have applied the science of Mechanics to practical matters, is the strength of materials: for example, the strength of a horizontal beam to resist being broken by a weight pressing upon it. This was one of the problems which Galileo took up. He was led to his study of it by a visit which he made to the arsenal and dockyards of Venice, and the conclusions which he drew were published in his *Dialogues*, in 1633. In his mode of regarding the problem, he considers the section at which the beam breaks as the short arm of a bent lever which resists fracture, and the part of the beam which is broken off as the longer arm of the lever, the lever turning about the fracture as a hinge. So far this is true; and from this principle he obtained results which are also true; as, that the strength of a rectangular beam is proportional to the breadth multiplied into the square of the depth: —that a hollow beam is stronger than a solid beam of the same mass; and the like.

But he erred in this, that he supposed the hinge about which the breaking beam turns, to be exactly at the unrent surface, that surface resisting all change, and the beam being rent all the way across. Whereas the fact is, that the unrent surface yields to compression, while the opposite surface is rent; and the hinge about which the breaking beam turns is at an intermediate point, where the extension