## TOPIC 5 - LOADING

## STRUCTURAL WEIGHT LIMITATIONS

Having established the minimum fuel requirements for a flight, the operator will often need to consider the maximum payload that can be carried, especially in commercial operations. One of the factors that may control the maximum payload possible is the limitations on aircraft weight imposed by the manufacturer. Because these limitations consider the stresses that can be tolerated by the aircraft structure, they are called structural limitations.

The structural **take-off weight** limitation
The structural **landing weight** limitation
The **zero fuel weight** structural limitation

**The structural take-off weight limitation** is imposed to prevent excessive loads on under-carriage components during the take-off run. It considers such things as side loads imposed by cross winds and the loads imposed by rough surfaces.

**The structural landing weight limitation** Many light aircraft manufacturers simply publish one structural weight limitation which applies to all flight situations. For example the Cessna 172 RG usually has a maximum weight limitation of 2650 lbs [1203 kg]. This is the maximum weight for take-off *or* landing. However some larger aircraft may have a different weight limit for landing which, because it considers the possibility of a heavier than normal landing, may be *lower* than the take-off weight limitation. It is imposed to prevent excessive loads on the undercarriage at touch-down and during the landing roll.

**The zero fuel weight structural limitation** is imposed on many larger aircraft to prevent excessive loads on the airframe during flight.

Compare the aircraft in the illustration in Fig 5.1 with the plank below. Since each wing contributes equally to total lift in normal flight, and the total weight of the aircraft acts through the centre of gravity which is located somewhere in the aircraft's fuselage, bending loads are imposed on the aircraft structure especially at the wing roots.

This arrangement of forces is similar to the situation depicted in the illustration at right. The plank is suspended by two ropes and a heavy weight is suspended from the centre of the plank.

The heavy weight represents items such as passengers and cargo which are normally placed in the fuselage.

Fig 5.1

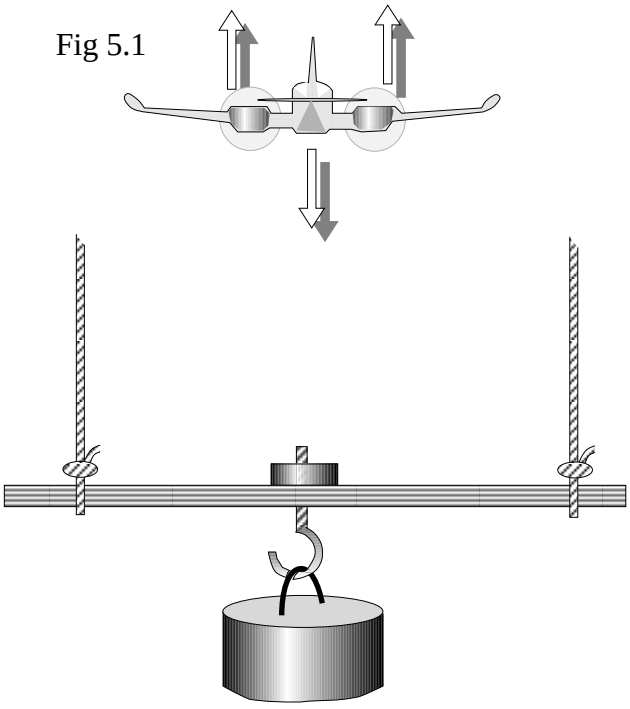
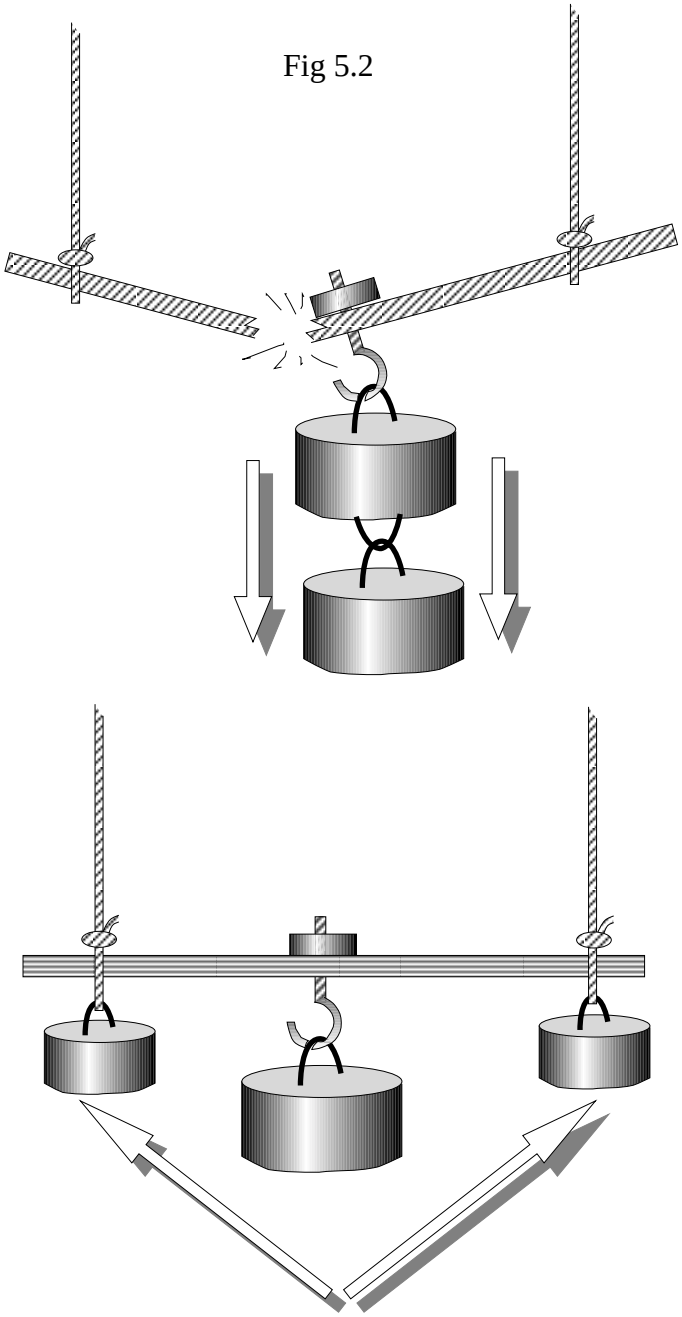


Fig 5.2



If the weight is increased the bending loads imposed on the plank will increase until the plank breaks under the increased load [Fig 5.2 top].

For some aircraft, a structural limit called the zero fuel weight limit, is imposed to prevent similar damage occurring at the wing roots. The zero fuel weight limit considers the possibility of the aircraft encountering turbulence in flight.

Because the fuel tanks are situated in the wings, the weight of any fuel on board does not contribute to these stresses [Fig 5.2 bottom], so any weight above this limiting weight must be in the form of fuel only.

Many twin engine aircraft have wing lockers which allow cargo to be loaded in the wings. The manufacturer however considers this effect when the zero fuel weight limit figure is calculated. The weight of *all cargo on board* is considered to act through the centre of gravity. This keeps things simple for the pilot - which is a good idea since many of us are not all that bright!

Extra weight added here with no increase in bending loads.

**DEFINITION:**

**THE MAXIMUM ZERO FUEL WEIGHT LIMITATION IS THE WEIGHT ABOVE WHICH ALL ADDITIONAL WEIGHT MUST BE FUEL ONLY. IT CONSIDERS THE STRENGTH OF THE AIRCRAFT STRUCTURE AND ALLOWS FOR THE LOADS LIKELY TO BE IMPOSED BY MANOEUVRING AND TURBULENCE.**