POLIPLEX® PE100

PHYSICAL CHARACTERISTICS

VISCO – ELASTICITY

When polyethylene is subjected to a tensile test, for example, the results obtained will vary greatly with changes in test conditions. That is the rate at which the load is applied, its duration, and the ambient temperature will all have an effect on the values obtained. Traditional engineering design practice relies on elastic theory in which stress is directly proportioned to strain, with the value of the elastic modulus obtained directly from a simple tension test of a few minutes duration. With plastics used in engineering applications, the stress-strain response is usually non linear and time dependant. When a constant load is applied plastics deform or strain immediately under the initial stress but then continue to deform at a much slower rate known as 'creep' for an infinite amount of time or until rupture occurs. Again when plastics are deformed or strained to a set amount, the magnitude of the stress reduces ie 'relaxes' with time. Therefore the use of strengths and moduli obtained by quick testing may be of limited use for long term design purposes. Instead of elastic moduli designers using plastics require the knowledge of creep and relaxation moduli.

Although in theory there is a difference between relaxation and creep moduli, in practice the numerical difference is quite small and they can be used interchangeably. (Ref. Fig 1.0)

Polyethylene has a particularly complex mechanical behaviour because its microstructure is a mixture of both crystalline and amorphous material. The crystalline regions deform elastically whereas the amorphous regions behave like a viscous fluid. Therefore the response to loading can be described as visco-elastic or a combination of these two types of mechanical behaviour.

Maxwell developed a mechanical model in which a dashpot operates in parallel with a spring, to demonstrate how viscous flow effects combine with elastic deformation. Using various versions of this device, the effect of loading rate together with the long term creep strain can be taken into account and the characteristics of different plastics modelled using appropriate constants. (Ref. Fig 2.0)

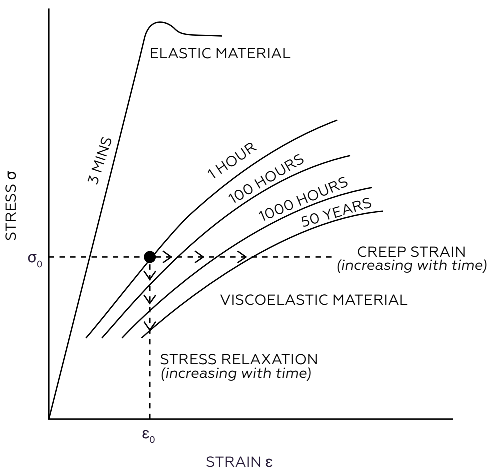

Figure 1.0 Stress-Strain characteristics for visco-elastic and elastic materials

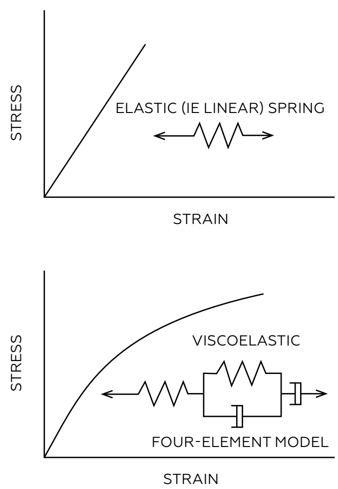

Figure 2.0 Mechanical simulation of visco-elastic behaviour using elastic springs and viscous dashpots