1.4 FIBER CHARACTERISTICS

Mechanical characteristics

1. Strength
2. Static fatigue
3. Dynamic fatigue

1. Strength

The cohesive bond strength of the constituent atoms of a glass fiber governs its theoretical intrinsic strength. Maximum tensile strength of 14 GPa is observed in short length glass fibers. This is closed to the 20 GPa tensile strength of steel wire. The difference between glass and metal is that, under an applied stress. The difference between glass and metal is that, under an applied stess, glass will extend elastically up to its breaking strength whereas metal can be stretched plastically well beyond their elastic range

Eg: Copper wires can be elongated plastically.

2. Static fatigue

It refers to the slow growth of the existing flaws in the glass fiber under humid conditions and tensile stress. This gradual flaw growth causes the fiber to fail at a lower stress level than that which could be reached under a strength test. The flaw shown propagates through the fiber because of chemical erosion of the fiber material at the flaw tip. The primary cause of this erosion is the presence of water in the environment which reduces the strength of SiO_2 bonds in glass. The speed of the growth reaction is increased when the fiber is put under test. Fused silica offers the most resistance of glasses in water. In general, coating are applied to the fiber immediately during the manufacturing process which affords a good degree of protection against environmental corrosion.

3. Dynamic fatigue:

When an optical cable is being installed on a duct, it experiences repeated stress owing to surging effects. The surging is caused by varying degrees of friction between the optical cable and the duct or guiding tool on a curved route. Varying stress also arises in aerial cables that are set into transverse vibration by the wind. Theoritical and experimental investigation have shown that the time to fail under these conditions is related to the maximum allowable stress by the same life time parameter that are in the cases of statics stress that increases at a constant rate.

Transmission characteristics

1. Attenuation

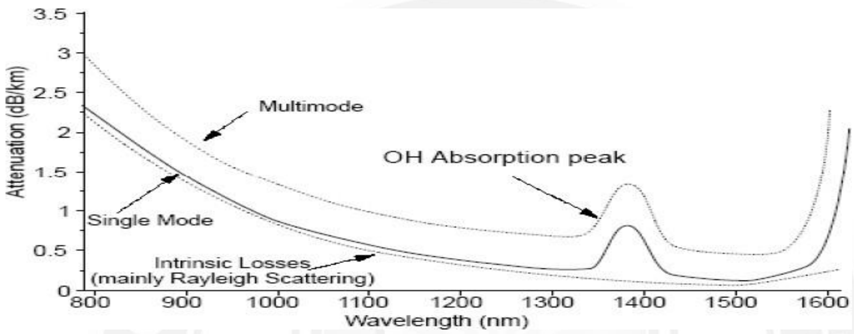

Figure 1.4.1 Fiber Infrared Absorption Spectrum

[Source: "Optical Fibre Communications" by J.M.Senior, Page: 54]

The lower curve shows the characteristics of a single-mode fiber made from a glass containing about 4% of germanium dioxide (GeO_2) dopant in the core. The upper curve is for modern graded index multimode fiber. Attenuation in multimode fiber is higher than in single mode because higher levels of dopant are used. The peak at around 1400 nm is due to the effects of traces of water in the glass.

Attenuation in fiber optics, also known as transmission loss, is the reduction in intensity of the light beam with respect to distance travelled through a transmission medium. Attenuation coefficients in fiber optics usually use units of dB/km through the medium due to the relatively high quality of transparency of modern optical transmission media. Attenuation in an optical fiber is caused by absorption, scattering, and bending losses.

Attenuation is the loss of optical power as light travels along the fiber. Signal attenuation is defined as the ratio of optical input power (P_i) to the optical output power (P_o).

Optical input power is the power injected into the fiber from an optical source. Optical output power is the power received at the fiber end or optical detector.

$$\text{Attenuation} = \left(\frac{10}{L}\right) \log_{10}\left(\frac{P_i}{P_o}\right)$$

Each mechanism of loss is influenced by fiber-material properties and fiber structure. However, loss is also present at fiber connections i.e. connector, splice, and coupler losses.