## 5.3 Short circuit ratio

It is defined as the ratio of field current required to produce rated voltage on open circuit to the field current required to circulate rated current on short circuit.

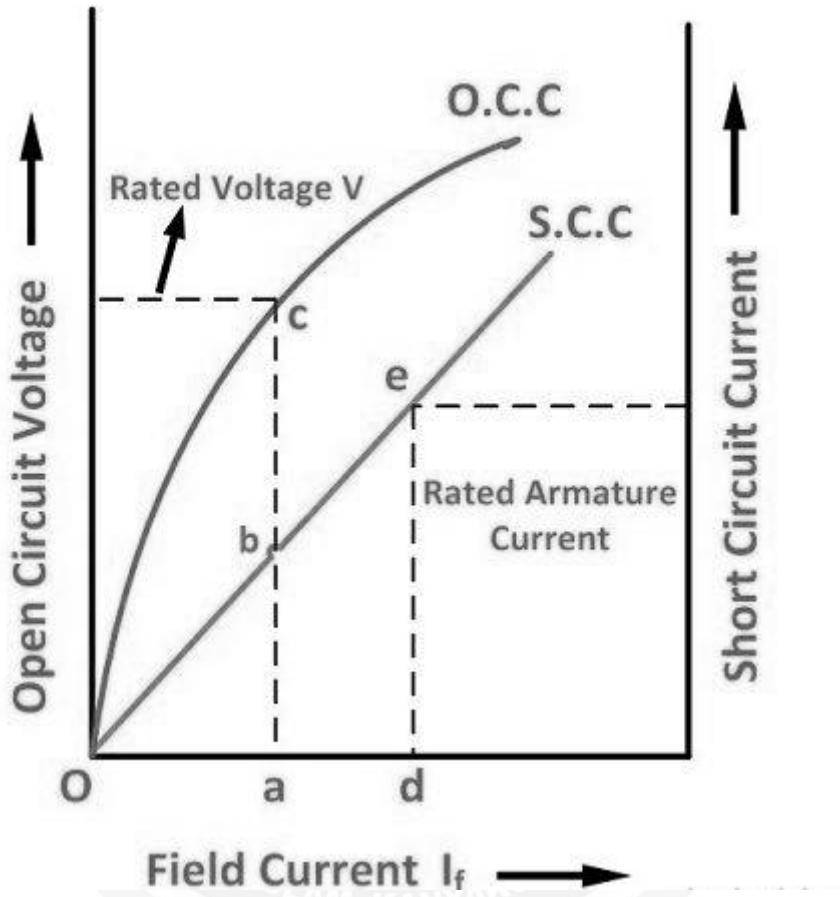


**Figure 5.3.1 O.C.C and S.C.C**

*[Source: "A Course in Electrical Machine Design" by A.K.Sawhney, page-11.18]*

The short circuit ratio can be calculated from the open-circuit characteristic (O.C.C) at rated speed and the short circuit characteristic (S.C.C) of a three-phase synchronous machine as shown in the figure below:

$$\text{SCR} = \frac{\text{If required to procuce O. C Voltage}}{\text{If required to produce S. C current}}$$

$$\text{SCR} = \text{OA/OD}$$

Since the triangles Oab and Ode are similar. Therefore,

$$\text{SCR} = \text{OA/OD} = \text{AB/DE}$$

The direct axis synchronous reactance Xd is defined as the ratio of open-circuit voltage for a given field current to the armature short circuit current for the same field current.

For the field current equal to Oa, the direct axis synchronous reactance in ohms is given by the equation shown below:

$$X_d = \frac{AC}{AB}$$

The per-unit value of Xd is given as:

$$X_{d(p.u)} = \frac{Xd}{\text{Base Impedance}}$$

But, the base impedance is:

$$\text{Base Impedance} = \frac{\text{Per phase rated voltage}}{\text{Per phase armature rated current}}$$

$$\text{Base Impedance} = \frac{AC}{DE}$$

Therefore,

$$X_{d(p.u)} = \frac{DE}{AB}$$

Therefore,

$$SCR = \frac{1}{Xd}$$

**Significance of SCR**

- If the value of SCR is low,

1. The synchronous reactance will be high and the regulation of machine will be poor.
2. Poor stability limit
3. The length of air gap will less. Hence less field copper. So expensive field winding.

- If the value of SCR is high,

  The machine will have a higher stability limit, low voltage regulation, a high value short circuit current, a larger air gap and hence expensive field system.

## Values of SCR

1. Cylindrical (or) Turbo alternator - 0.5 to 0.8 average 0.6
2. Water wheel alternator - 0.9 to 1.0 or even 2
3. Synchronous condenser - 0.4