5.4 Rate of rise of recovery voltage

- When a fault occurs, the energy stored in the system can be considerable. Interruption of fault current by a circuit breaker will result in most of the stored energy dissipated within the circuit breaker, the remainder being dissipated during oscillatory surges in the system.
- The oscillatory surges are undesirable and, therefore, the circuit breaker must be designed to dissipate as much of the stored energy as possible. Equivalent circuit where L *is* the inductance per phase of the system up to the point of fault and *C* is the capacitance per phase of the system. The resistance of the system is neglected as it is generally small.
- It is the rate of increase of re-striking voltage and is abbreviated by R.R.R.V. usually; the voltage is in kV and time in microseconds. so that R.R.R.V. is in kV/μ sec.

Consider the opening of a circuit breaker under fault conditions shown in simplified form in Fig:

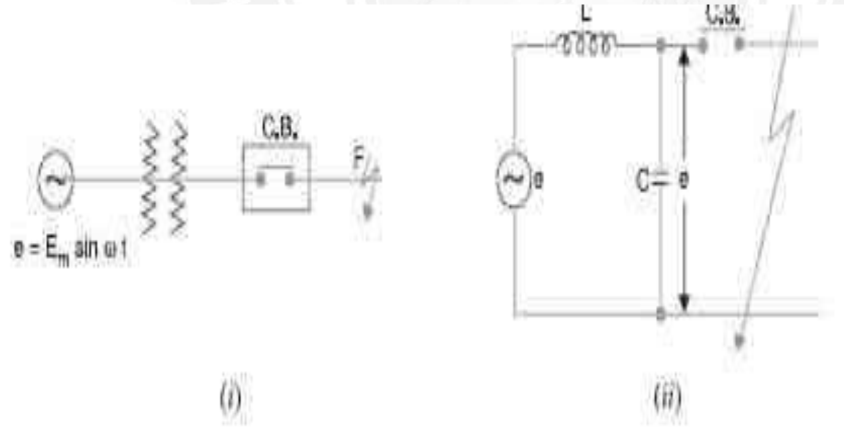

Figure 5.4.1 (i) Short circuit occurring on the transmission line
(ii) Equivalent circuit of transmission line

[Source: "Principles of power system"" by V.K.Metha, Page: 465]

- Before current interruption, the capacitance *C* is short-circuited by the fault and the short-circuit current through the breaker is limited by inductance *L* of the system only.
- Consequently, the short-circuit current will lag the voltage by 90º as shown in Fig., where *I* represents the short-circuit current and *ea* represents the arc volt-

age. It may be seen that in this condition, the entire generator voltage appears across inductance *L*.

- When the contacts are opened and the arc finally extinguishes at some current zero, the generator voltage e *is* suddenly applied to the inductance and capacitance in series. This *L–C* combination forms an oscillatory circuit and produces a transient of frequency:

$$f_n = \frac{1}{2\pi\sqrt{LC}}$$

- The above frequency appears across the capacitor *C* and hence across the contacts of the circuit breaker. This transient voltage, as already noted, is known as re-striking voltage and may reach an instantaneous peak value twice the peak phase-neutral voltage *i.e.* 2 *Em*.

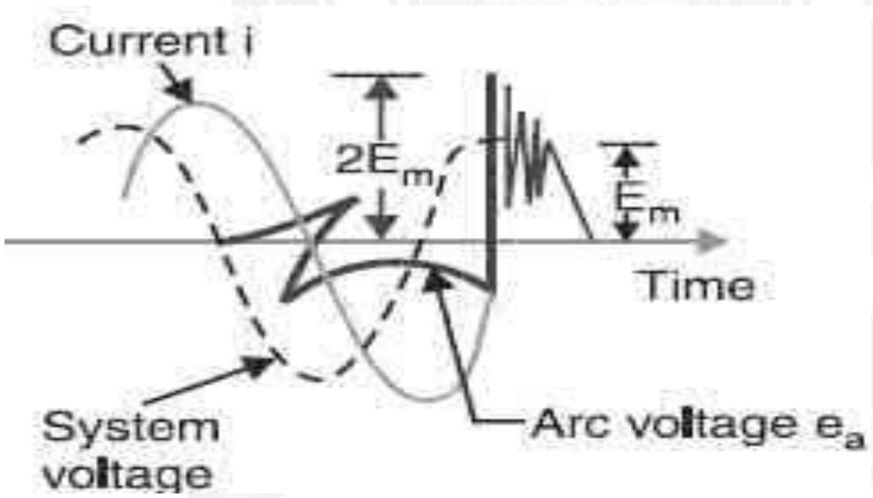

Figure 5.4.2 Classification of Switchgear
[Source: "Principles of power system'" by V.K.Metha, Page: 465]

- The system losses cause the oscillations to decay fairly rapidly but the initial overshoot increases the possibility of re-striking the arc. It is the rate of rise of re-striking voltage (R.R.R.V.) which decides whether the arc will re-strike or not.

- If R.R.R.V. is greater than the rate of rise of dielectric strength between the contacts, the arc will re-strike.
- However, the arc will fail to re- strike if R.R.R.V. is less than the rate of increase of dielectric strength between the contacts of the breaker.
- The value of R.R.R.V. depends upon: Recovery voltage, Natural frequency of oscillations.