EARTHQUAKES & SEISMIC COMPLIANCE OF LV SWITCHGEAR ASSEMBLY

TECHNICAL ARTICLE

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Earthquakes & Seismic Compliance of LV Switchgear

Random vibrations, such as those caused by an earthquake, cause shocks and ground movements and are termed seismic disturbances. Seismic considerations and switchboard designs are seems to be unrelated for most of us. But increasing incidents of earthquakes across the country has compelled the designers and users to think of seismic testing of switchboards and other electrical installations. The whole country fall's under some seismic zones. To understand this first we will discuss how it is getting measured and its impact on secondary system.

Measurement of Magnitude & Intensity

The magnitude of shocks and vibrations caused by an earthquake is the measure of energy released (E) at the focal point in the form of seismic waves. Most commonly used and classical measure of magnitude of earthquake is Richter Scale (also called as local magnitude ML). An American seismologist called Charles Richter suggested that the magnitude of an earthquake can be expressed by

Richter Magnitude	Earhquake Effect
0-2	Not felt by people
2-3	Felt little by people
3-4	Ceiling lights swing
4-5	Wall cracks
5-6	Furniture Moves
6-7	Some buildings collapse
7-8	Many building destroyed
8-Up	Total distruction

M = log A, where

M=magnitude of the earthquake

A= maximum amplitude, as recorded by the Wood Anderson seismograph in microns at a distance of 100 km from the epicenter.

Earthquakes & Seismic Compliance of LV Switchgear

The minimum value of M which may cause appreciable damage is considered to be about 5. The energy released during earthquake is enormous. To get an idea of the energy that may be released and the destruction that it can cause, one may compare it with the energy of 8 x 10^{20} ergs released during the atomic explosion at Hiroshima, Japan, in 1945. This is equivalent to an earthquake of M = 6.33. The extent of destruction may be equivalent to an explosion of 10 such bombs if M is 7.0 and many times more at yet higher magnitudes

An earthquake may last for 4-6 seconds only for M =5.5 or less and for over 40 seconds for M > 7.5. The greater the magnitude, longer will be the duration. An earthquake of M > 6, for instance, may last for 15-30 seconds and produce a maximum horizontal ground acceleration of the order of 0.1g to 0.6g (98 cm/s^2 to 590 cm/s^2) and higher, inflicting maximum damage in the first 5-10 seconds only, and a frequency band between 1 and 33 Hz (IEEE 344).

Earthquake Zones in India:

Center for Seismology, Ministry of Earth Sciences is nodal agency of Government of India dealing with various activities in the field of seismology and allied disciplines. The Indian subcontinent has a history of devastating earthquakes. The major reason for the high frequency and intensity of the earthquakes is that the Indian plate is driving into Asia at a rate of approximately 47 mm/year. Geographical statistics of India show that almost 54% of the land is vulnerable to earthquakes. A World Bank & United Nations report shows estimates that around 200 million city dwellers in India will be exposed to storms and earthquakes by 2050. The latest version of seismic zoning map of India given in the earthquake resistant design code of India [IS 1893 (Part 1) 2002] assigns four levels of seismicity for India in terms of zone factors. In other words, the earthquake zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5).

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According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.

Zone 5

Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity Medvedev–Sponheuer–Karnik scale (MSK) IX or greater. The IS code assigns zone factor of 0.36 (maximum horizontal acceleration that can be experienced by a structure in this zone is 36% of gravitational acceleration) for Zone 5. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the western and central Himalayas, North and Middle Bihar, the North-East Indian region and the Rann of Kutch fall in this zone.

Zone 4

This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns zone factor of 0.24 for Zone 4. The Indo-Gangetic basin and the capital of the country (Delhi), Jammu and Kashmir fall in Zone 4. In Maharashtra, the Patan area (Koyananager) is also in Zone 4. In Bihar the northern part of the state like- Raksaul, near the border of India and Nepal, is also in Zone 4.

Image courtsey:Wikipedia

Zone 3

The Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under this zone. This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII and also 7.8. The IS code assigns zone factor of 0.16 for Zone 3.

Zone 2

This region is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of 0.10 for Zone 2.

In further discussions we consider only the secondary systems that are supported on the primary system and consist mainly of the electrical and mechanical machines, devices and components. The primary systems, which include houses, buildings and main structures, dams and bridges etc., fall within the purview of civil and structural engineering and are not discussed here.

Need of Testing a System for Seismic effect

During the seismic vibrations power contacts, cables & wire connections, internal components of switchgear & other devices may get misaligned. This could lead to malfunctioning of the equipment post-earthquake. A study of seismic effects on a structure, equipment or device will reveal its worthiness to withstand an earthquake without appreciable damage and perform satisfactorily during and after sudden shocks and vibrations. It is possible to study their performance through prescribed seismic withstand tests.

Assembly Testing for Seismic withstand

It is normal to test large complex assemblies by simulating the most critical in-service conditions. In such a case, the specimen is subjected to the required seismic input motion while the operating conditions are applied or simulated and while its performance is recorded during the tests.

After testing, the assembly shall be inspected and the integrity of all the unmonitored devices, such as cabling, checked. The purpose of installing inoperative devices is to ensure that the specimen possesses the same dynamic characteristics as in normal operation.

Seismic testing is a complex subject and providing details of testing procedures & acceptance criterion is not the objective of this paper. Though it can be referred from relevant standards.

National & International Standards on switchgear assemblies normally not required such tests. They become vital when electrical equipment's are installed in Nuclear Power Plant (NPP) malfunctioning of equipment's proved to be catastrophic. But still it is advisable to get the assembly tested for at least if it has to be installed in Zone-IV & V even for installations other than NPP.

Picture courtsey: Tricolite Electrical Industries Limited

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Observations after a successful Seismic Test

- After seismic test Switchboard is subjected to visual inspection. The desired observations are
- No permanent deformation, dislocation, breakage or cracks
- No loosening of components/equipment's from their original mounting and
- Doors to remain in closed position as was before test
- Mounted equipment's should be in operational state in energized condition

What to do with your electric panel system, in case you feel a tremor in your factory and are at shop floor and " How can TRICOLITE be of help "