PRODUCT INFORMATION

EARTHQUAKE CALCULATION ON TAP-CHANGER, TYPE UZE/UZF

General

The transformer and its foundation is assumed to be rigid but not stiff, so the ground acceleration \( a_{HG} \) is considered to be amplified through the transformer tank to the tank cover with the amplification factor \( K \), which is prescribed to be 1.5 (IEC 1463).

Static calculation on a somewhat flexible structure, taking into consideration the response factor \( R \) as an alternative to the method by dynamic analysis, gives a simple and at the same time a more conservative method for calculation.

The bending moment \( M_s \) in the critical cross-section on the part of the tap-changer under consideration is then calculated from an equivalent acceleration \( a_{MP} \) of the centre of gravity of that part:

\[
M_s = a_{MP} \times h \times m_p
\]

The acceleration \( a_{MP} \) is calculated from the cover acceleration \( a_{HC} \) by multiplication with a coefficient \( S_c \) and the response factor:

\[
a_{MP} = a_{HC} \times S_c \times R
\]

The value of \( S_c \) depends on the natural frequency of the mounted part and if no value is known, the conservative value \( S_c = 1.5 \) should be used. This coefficient aims to take into account the effects of both multifrequency excitation and multimode response. \( R \) can be assumed to be equal to the conservative value 1.74 when information for frequency and damping of the tap-changer on a transformer is not available. This value corresponds to the frequency range 2.4 Hz to 9 Hz and 5% damping ratio.
Calculation

(Calculation of the load and stress on the clamping screws of the tap-changer's epoxy resin moulding)

For the tap-changer UZE/UZF is the following valid:

\[ h_1 = 0.7 \text{ m} \quad h_2 = 3.0 \text{ m} \quad \text{(Conservative values)} \]
\[ m_{pl} = 40 \text{ kg} \quad h_1 = 0.25 \text{ m} \quad K = (h_1/h_2) \times 1.5 \quad R = 1.74 \quad S_c = 1.5 \]

Assume the strongest type of earthquake with a ground acceleration level \( a_{HG} = 0.5g \) (Richter scale >7.0) which gives that:

\[ a_{HG} = 5 \text{ m/s}^2 \quad a_{HC} = K \times a_{HG} \quad a_{MP} = a_{HC} \times S_c \times R \]

The bending moment \( M_s \) in the critical cross-section will be:

\[ M_s = a_{MP} \times h \times m_p \quad M_s = 45.675 \text{ Nm} \]

The force \( F \) from the acceleration is:

\[ F = a_{MP} \times m_p \quad F = 182.7 \text{ kg \cdot m \cdot s}^{-2} \]

The distance \( h_{E2} \) between the clamping screws which hold the epoxy resin moulding is 240 mm. Six screws M16 on each side clamp the moulding and are prestressed to about 8 kN. The balance between the force \( F \) from the acceleration \( a_{MP} \) and the reaction forces \( F_2 \) at the clamping area gives that \( F_2 = 190 \text{ newton} \). It means that even a single screw (with prestress of 8 kN) would be enough to take care of the force \( F \) from the earthquake acceleration. In practice the number of screws is six.

**NOTE:** The mass \( m_p = 40 \text{ kg} \) does not include the part of the epoxy resin moulding, which is close to the transformer wall connection.

*(Ref.file for calculations: earthuz.mcd)*