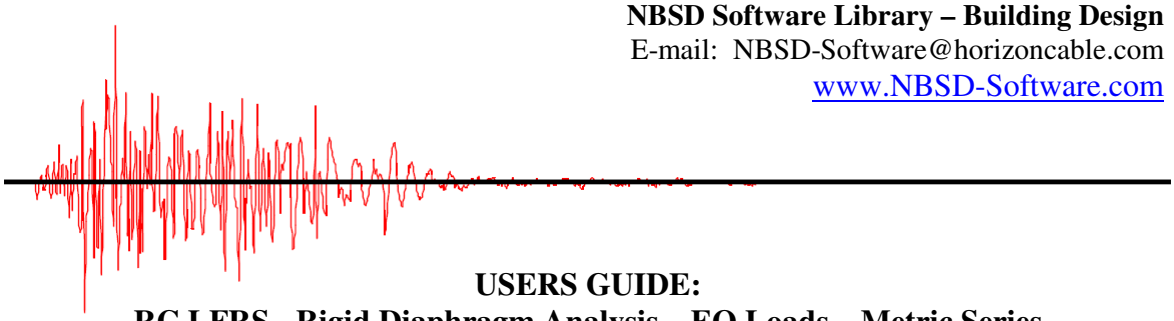


USERS GUIDE:
RC LFRS - Rigid Diaphragm Analysis – EQ Loads – Metric Series

This document provides guidance to the User as to the correct use and implementation of the following NBSD Software Library tool:

RC LFRS RDA – EQ Loads M1 (MPa).xls or M2(Mks).xls

The above referenced Excel Software Tools are provided for determination of seismic loads to Reinforced Concrete (RC) Lateral Force Resisting System (LFRS) elements in Simple Buildings assuming Rigid Diaphragm Analysis (RDA) assumptions, where loads are distributed to resisting elements according to their relative stiffness and location away from the Center of Rotation (COR) of the rigid diaphragm. RC elements may be either Shear Walls or Special Moment Resisting Frame (SMRF) beams and columns. These software tools use Metric (MPa or Mks – Kgf/cm^2) Units.

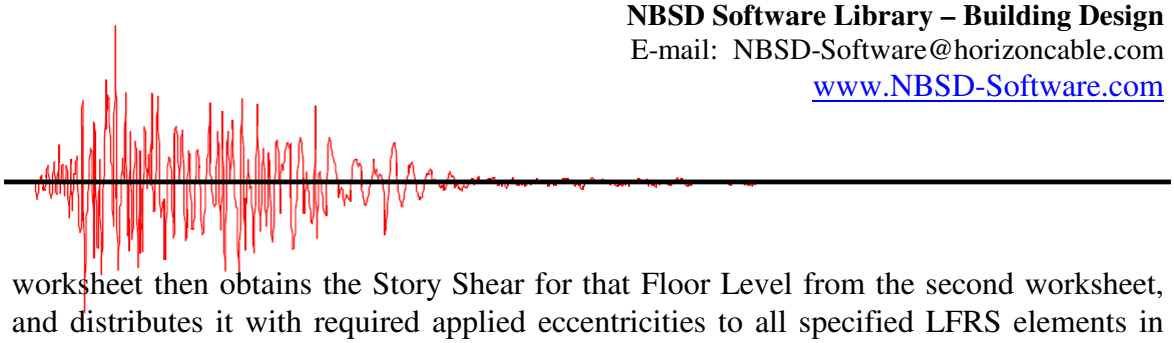
Earthquake loads (EQ) are assumed transferred by an RC Slab (at any particular Floor Level within a building, one at a time) per RDA assumptions to up to 32 RC LFRS elements in both orthogonal directions within the specified diaphragm. The User is permitted to use a stiffness value derived elsewhere (perforated or oblique walls, etc) for individual elements, but otherwise the stiffness of specified rectangular elements are calculated internally. The Rigid Diaphragm is a Reinforced Concrete (RC) slab of uniform thickness, defined in up to three rectangular sections to allow for simple horizontal irregularities (L, T, etc).

This software tool consists of seven separate worksheets, for which data is provided by the User in two of the first three worksheets to define the RC building in both orthogonal directions, and results then provided for a Floor Level chosen (third worksheet) in the last five worksheets (shear forces, displacements, over-turning forces, summary, member forces). The resulting building cross section and Elevations (Front and Side) are provided for reference in all worksheets (within or outside Print Area of document).

In the **first** worksheet, basic input data (LFRS type, cross section, floor levels and weight) is provided to define a RC building (up to 20 stories) in both orthogonal directions with a single roof level and a RC Rigid Diaphragm comprised of up to 3 rectangular sections (L, H, etc). Each building direction (N-S or W-E) may have a different LFRS specified.

In the **second** worksheet, EQ forces are determined internally for the building in both orthogonal directions using the Equivalent Lateral Force (ELF) Procedure of ASCE 7 Section 12.8 for building structures. Floor weight and elevation at floor levels (from first worksheet) are used to determine the Base Shear and distribution of lateral forces along the height of the building for each LFRS direction.

In the **third** worksheet, the Floor Level of interest is chosen, and LFRS elements in each orthogonal direction are defined (Shear Walls or SMRF's) for which the lateral (individual and relative) stiffness of each element node is determined internally. This



worksheet then obtains the Story Shear for that Floor Level from the second worksheet, and distributes it with required applied eccentricities to all specified LFRS elements in both directions.

In the **fourth** worksheet, elastic displacements are obtained at every RC LFRS element (specified in the second worksheet) as well as the Drift Ratios (Beam, Column, and Total) to determine and help fine-tune the selection of SMRF Beam and Column sizes to meet drift requirements (checked subsequently) For the results obtained, ASCE 7 Table 12.3-1 Horizontal Irregularities 1a and 1b (Torsional and Extreme Torsional) are immediately checked, and adjustments provided (A_X) if found to be irregular.

Elastic Displacements at a Floor Level, once determined, need to be converted to amplified or non-linear displacements (by multiplying with C_d / I to account for non-linearity of results, per ASCE 7 Section 12.8.6), then converted to Interstory Drift, and then compared to Allowable Story Drifts (per Table 12.12-1) to verify adequacy of the building (stiffness, P-Delta, etc); displacement results obtained in this software tool can be used in parallel with another software tool (ASCE 7-10 EQ Loads and Criteria.xls) to determine adequacy of LFRS elements for design prior to beginning that effort.

In the **fifth** worksheet, Overturning (OT) forces from diaphragms above the Floor Level of interest are retrieved (both directions) from the first worksheet (EQ Loads). These overturning moments are then distributed according to the distance of each element from the Center of Rotation of the RC LFRS at the Floor Level being evaluated, and applied as OT axial forces to each RC element (which could be in tension or compression).

The **sixth** worksheet provides a summary of all RDA results, while the **seventh** provides SMRF column and Beam demands, for the Floor Level being evaluated in unlocked worksheets, in order to allow the User to retrieve and edit the results obtained easily for comparison purposes (i.e. other floors, wind loads, etc).

The following Worksheets are provided in this software tool:

- 1. Building Type, Size, Weight;
- 2. Code Level Story Forces – EQ;
- 3. RDA Shear Forces;
- 4. RDA Displacements;
- 5. RDA Axial OT Forces;
- 6. RDA Results Summary;
- 7. SMRF Member Demands;