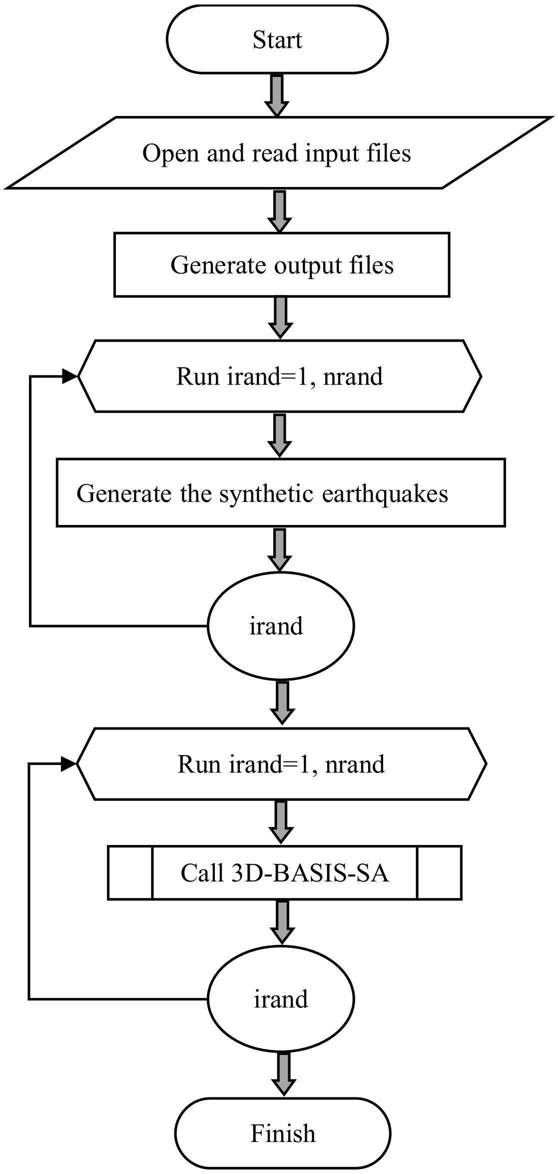

Fig. 4. General flow chart of 3DBASIS-SA-MC program

4.3 Simulation and Results

A sample Monte-Carlo simulation of the 3-story benchmark semi-active isolated building is carried out for nrand=3000 simulations using 3DBASIS-SA-MC program. The building is subjected to synthetic near-fault earthquakes with a moment magnitude of 6.5 and a closest distance to the fault of 3 km. For conducting nrand=3000 simulations, random parameters of semi-active isolation system (α, F_y, D_y, k_d, c_{max} and c_{min}) and synthetic earthquake model (ζ_p, T_p and υ_p) are generated with 3000 different random values following certain probabilistic distributions (see Tables 3 and 4). The results are presented in the form of cumulative distribution functions (CDF) (Fig. 5). CDF plots can be used to determine the reliabilities of the investigated buildings as they provide information on the probability of exceedances corresponding to any selected limit state value. CDF plots in this study are constructed in terms of peak top floor acceleration (pfta) and peak base displacement (pbd) response parameters (Fig 5).

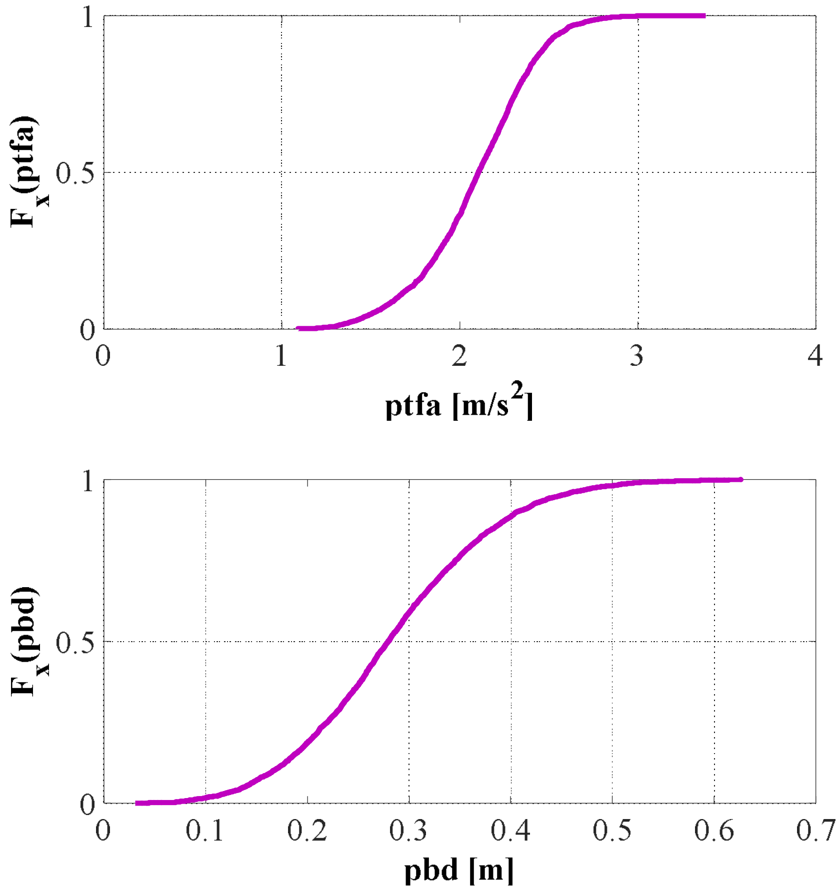

Figure 5. CDF plots of peak top floor acceleration (pfta) and peak base displacement (pbd)

When CDF plots are examined, it is clearly observed that the results appear in a wide range as opposed to single-valued counterpart deterministic results that would be obtained using nominal values given in Tables 3 and 4. Compared to the deterministic peak base displacement value of 28 cm, the probabilistic values of peak base displacements obtained from Monte-Carlo analysis vary between 3 cm and 63 cm. Compared to the deterministic peak acceleration value of 2.1 m/s^2, the probabilistic values of peak top floor accelerations obtained from Monte-Carlo analysis vary between 1.1 m/s^2 and 3.4 m/s^2. These plots can effectively be used to determine probability of failures. For example, 50% and 95% of peak top floor accelerations are below about 2.1 m/s^2 and 2.6 m/s^2, respectively. That is, the probability of peak top floor acceleration exceeding 2.1 m/s^2 and 2.6 m/s^2 is 50% and 5%, respectively. Similarly, the probability of peak base displacement exceeding 28 cm and 45 cm is 50% and 5%, respectively.

5 Conclusions

In this study, it is explained how Monte-Carlo simulation method is applied to a typical semi-active isolated building by making use of a 3-story benchmark structure with random isolation system characteristic parameters under synthetic earthquakes also with random characteristic parameters. For performing Monte-Carlo simulation, the previously modified version [11] of 3DBASIS program [12], which is able to conduct seismic analysis of semi-active isolated buildings, is further modified to perform recursive analyses with random variables under synthetic earthquakes. As the output of the Monte-Carlo analysis, cumulative distribution plots are constructed which depicted that the seismic response parameters of the semi-active isolated benchmark building attain values in a wide range as opposed to single-valued deterministic results. In addition, it is demonstrated how these cumulative distribution function plots can effectively be used in determining probability of failures and thus reliability levels. It is thus shown that via this probabilistic approach, the seismic behavior of semi-active isolated buildings can be determined more realistically.

In an ongoing study conducted by the authors of this study, CDF plots for a wide range of different M_w and r values are generated via Monte-Carlo analysis described here in order to assess the reliability levels of semi-active isolated buildings subjected to different practical and economical limits of peak base displacements and peak top floor accelerations under near-fault earthquakes.

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