The duration of earthquake ground motion anticipated at a site is not explicitly considered in current guidelines for structural performance assessment and design. They, instead, focus almost exclusively on response spectra, which quantify a ground motion’s amplitude and frequency content. Duration and other ground motion characteristics are treated only qualitatively. This study outlines a procedure to compute source-specific target distributions of ground motion duration at a site. The proposed procedure is used to compute hazard-consistent target distributions of duration at three sites in Western USA—Seattle, Eugene, and San Francisco—with varying levels of contribution to their seismic hazard from different types of seismic sources. An eight-story reinforced concrete moment frame building is then analyzed using two groups of ground motions, carefully selected to estimate the effect of duration on structural response, while controlling for the effect of response spectral shape. These analyses demonstrate that the mean annual frequency of collapse of structures located near active subduction zones is underestimated if analyzed using typical short duration ground motions from the PEER NGA-West2 database, instead of hazard-consistent ground motions whose durations match the computed source-specific targets. Therefore, inadvertently using shorter duration ground motions than those anticipated at a site could produce unconservative structural designs, with lower margins of safety against collapse. This warrants a more explicit consideration of ground motion duration when selecting records for structural collapse risk estimation, similar to ground motion response spectra. It also motivates the need to incorporate the effect of duration into code-based seismic design guidelines.