Analysis of Blast Loading Effects on Elements of Reinforced Concrete Buildings

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Iconic, public and commercial buildings have become a universal target of bomb attacks from terrorists. Those buildings are the lifeline structures and they play an important role in the economy of a country. Hence they have to be protected from blast loading. However, most of these buildings have been or are built without consideration for their vulnerability to such events. Hence buildings used by the general public daily must also have satisfactory blast protection. The main objective of this study is to evaluate blast effect on a reinforced concrete (RC) building considering experimentally determined dynamic characteristics. This study involved theoretical calculation of the characteristics of blast according to Unified Facilities Criteria and computer simulations as the non-linear pressure-time history analysis by using the SAP2000 version 15. This study mainly divided in to two parts. The first part involved with experimental activity which is blast explosion has done for the RC column model series to show accuracy of above techniques with actual results. The second part involved with applying above technique to the Colombo Regional Centre (CRC) stage II building to achieve the main objective. The experiment was done for four blast scenarios of 1.5kg and 2kg with constant stand-off distance of 4.5m. As the results the SAP2000 analysis, theoretical calculation and experimental result analysis were show approximately same results. Therefore, the method used in this research work can be used for assessing vulnerability, damage and residual strength capacity of building frames and component elements subjected to near field blast events. Secondly, the blast loading analysis of CRC stage II building was done for six scenarios with two different stand-off distances and three different amounts of charge weight as the surface burst. As the results of this analysis the SAP2000 software have shown that columns and beams at 2nd floor level of CRC stage II building (at OUSL) are critical for the explosion with charge weight 200kg at stand-off distance 13.7m. The experimental results illustrate that strains of circular shape columns are higher than those of square shape columns. Blast loading effects on element were differing with its geometrical properties and the geometric properties govern the structural response than the dynamics of the structure. In the experiment, there were not identified any significant blasting effects such as cracks, demolishing or toppling of columns. When charging weight is increased, peak reflected over pressure also increases. Further, peak reflected over pressure decreases with the stand-off distance. Based on finding on the research, it is recommended that guidelines on abnormal load cases and provisions on progressive collapse prevention should be included in the current Building Regulations and Design Standards. Requirements on ductility levels also help improve the building performance under severe load conditions.

Key words: Blast load, computer simulations, blast effect, non-linear pressure-time history