RISK AND UNCERTAINTY MODELLING OF COLLATERAL DAMAGE FROM MONOLITHIC GLAZING SUBJECT TO EXPLOSIVE BLAST LOADS

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ABSTRACT

The modelling of consequences to built infrastructure when subject to blast loading is well developed; however, there is considerable uncertainty and variability with explosive loading and system response; which provides many challenges for collateral damage estimation. In this paper, structural facades are assessed – with a focus on glazing – as this is a structural and load-capacity system that poses significant safety hazards (and thus collateral damage hazards) when effected by explosive blast loads. A new computational software tool – called "Blast-RF" (Blast Risks for Facades) – is used to undertake a probabilistic risk assessment procedure to predict damage and safety hazard risks following blast loading of glazing. The probabilistic and structural reliability analysis uses stress limit states and the UK Glazing Hazard Guide's rating criteria to calculate probabilities of glazing damage and safety hazards for a given blast scenario. This allows the prediction of likelihood and extent of damage and/or casualties; information which will be useful for collateral damage estimation. The literature shows that the variability of blast-load parameters such as pressure and impulse often exceeds ±40%; e.g., when some blast test results are compared to the well accepted CONWEP model, the model error (accuracy) for blast-load reduces to as low as 0.7 and for others up to 1.5. Hence, the probabilistic analysis considers the variability of explosive blast loads; in particular, from variations in explosive weight, explosive material energetic output, stand-off distance, accuracy of the blast load prediction model and the inherent variability of blast loading. The analysis then considers how these variabilities affect structural response; whilst also including the variability in glazing stress limits and geometry, fragment drag coefficients and solver modelling error. Safety hazard risks are calculated for glazing in a typical 20 storey commercial building for a range of blast scenarios. It will also be shown how probabilistic modelling of risks to facades could complement current collateral damage estimation methodologies; particularly in the conduct of military operations within urban or complex environments.