DEVELOPING A GIS-BASED MODEL FOR ROAD BLOCKAGE ASSESSMENT

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Immediately after disastrous earthquake events, the knowledge regarding the status and the potential performance of the road network is essential in managing related emergency activities such as search and rescue and evacuation of injured and dead people. In most urban settings of Iran, especially in old fabrics, buildings are densely packed within their neighborhood while surrounded by relatively narrow or congested roads. A large number of constructions are severely vulnerable and potentially subject to collapse resulting in the spread of large amount of debris around them after severe ground shaking. Although the collapse of some network elements such as bridges, overpasses, tunnels, etc…, are very important; but, the debris spread can be regarded as the major cause of transportation failure in such urban settings.

This research brings upon two novel approaches in modeling the road blockage. Firstly, the debris caused by damage to buildings are treated separately according to different building typology (including structural type, height, age…) and the associated proximity to the roads considering each building footprint widths. And secondly, the potential blockage share of each building is estimated by the relative debris heap and the road width.

Transportation infrastructure system has important spatial characteristics, because it connects different locations with various attributes. Geographic Information Systems (GIS) is a useful tool in creating efficient databases and for analyzing complex transportation systems as utilized in this study for implementation. Three phases are completed in this study as it follows:

- Creating seismic hazard database for the study area and developing building and road network inventories;
- Developing the road blockage model and incorporating related structural vulnerability functions for the study area;
- Implementing the entire data and models within GIS.

The possibility of road blockage caused by debris depends on the different factors like the number of collapsed buildings, characteristics of buildings along the road, the ratio between building height and the distance from front-walls of the buildings to the road center line. The blockage assessment tries to quantify the probability of debris occupying the road. A final debris heap width W_D is a function of several factors such as the percentage of collapsed and extensively damaged buildings (DF), the coefficient of building structure type (W_S) and the coefficient of building height (W_H) as is calculated as:

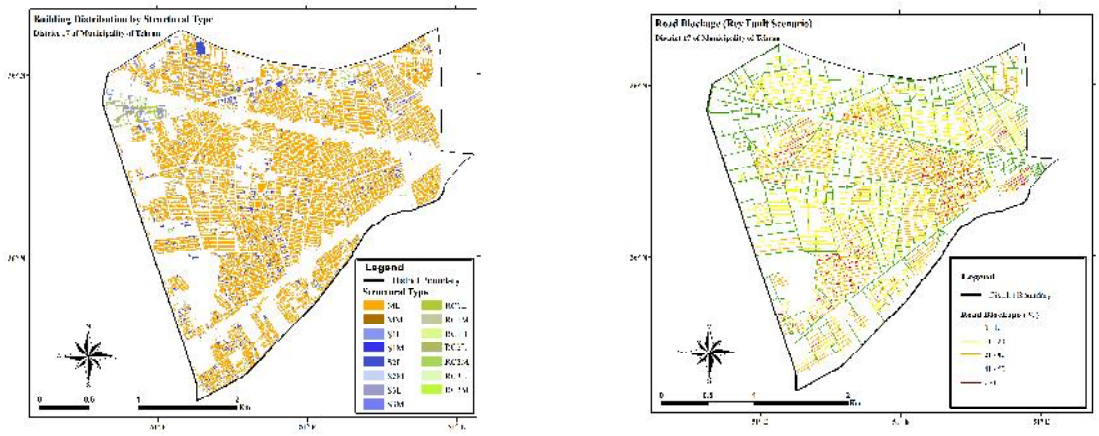
$$W_D = W_S \times W_H \times DF \quad (1)$$

The ratio between the debris heap width on one side of the road and the useable width of the intact road (W_R) is used to evaluate the lateral blockage by debris on the road surface at the corresponding road segment. This ratio is calculated as:

$$RB = \frac{W_D}{W_R} \quad (2)$$

For the implementation phase of the algorithm, the District 17 of Municipality of Tehran is chosen due to its old vulnerable buildings. Another reason for this site selection is that enough inventory data (reflecting parcel level of resolution) is gathered, pre-processed and made GIS ready and is shown in figure 1-a.

Two Ray fault and North Tehran fault models are considered as earthquake scenarios. The microzonation maps for two default scenarios have been considered as input for the building loss estimation and stored in the geodatabase. By relating series of damage curves introduced for Tehran (Mansouri et al., 2013), expected structural damage are evaluated within the extent of the study area for this two earthquake scenarios. The debris from collapsed buildings that are adjacent to the roads and face directly to the same road are assumed to be the main cause of the road network blockage, thus the proximity analysis is performed to determine the parcel distance relative to the road. Finally, the lateral blockage is estimated by debris heap value at each corresponding road segment where the road blockage map is presented for the area of interest (Figure 1-b).



a) Distribution of Buildings inventory based on building types

b) Severity of Road blockage

Figure 1. Severity of Road blockage for District 17 of Municipality of Tehran (Ray Fault Model Scenario)

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