# Evaluation of Fault Setback in Urban Area (A case study: South Mashhad Fault)

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## Abstract

Safety design of structures concerning surface faulting effects such as shear and differential subsidence are very costly and in some cases are impossible. Then the appropriate approach for encountering surface faulting is to determine a suitable fault-avoidance zone. In this study, firstly the theorem of avoidance fault zone is presented, and then the setback area from the fault zone of South Mashhad fault is proposed. Recent studies show that South Mashhad fault is a right-lateral strike-slip fault with a normal component that cut the Quaternary sediments. In this work, the average slip rate and estimated return period for South Mashhad fault are 0.59 mm/yr and 2930 years, respectively. Accordingly, the proposed avoidance zones in the south (hanging-wall) and north (foot-wall) of the fault are 80 and 70 meters, respectively. Considering the avoidance zones, many residential and other important structures are located in the avoidance zone of the South Mashhad fault.

**Keywords:** Fault-Avoidance Zone, South Mashhad Fault, Active Fault

## Extended Abstract

### Introduction

Iran is geologically located in the active continental collision zone of Alp-Himalayan tectonic belt and the pressures resulted from subduction of the Arabian Plate beneath the Iranian micro continent produced major faulting, folding and fracture systems in central Iran plate. Several geological indications were attributed to these tectonic activities particularly the generated earthquakes with significant displacement in faulting zones and destruction of building foundations. Spreading the shear zone in foundations, displacement and dis-harmonic settlement of foundations, compressional tensions, horizontal strains and extensional fractures are the most important surface effects to failure the constructions. Thus, for encountering surface faulting and evaluation the fault setback in urban areas it is essential to determine the suitable fault avoidance zones for application of the land in residential areas.

### Methodology

The present work, characterizes the South Mashhad fault based on the morphotectonic and geophysical methods, and recognizes the fault as type II using the existing criteria and the setback area from the fault zone. Due to the widespread occurrence of alluvial sediments which cover the fault line (Fig. 1), the track of South Mashhad fault was recorded based on the geo-electric, geo-magnetic and microtermore array methods (e.g. Fig. 2). The average slip rate and return period for South Mashhad fault were proposed 0.59 mm/y and 2930 years, respectively. Based on the existing active fault criteria, the proposed avoidance zones of the fault in south (hanging wall) and north (footwall) are 80 and 70 meters, respectively. According to the GPS data, displacement rate of Kopeh-Dagh Basin relative to Binalood zone was calculated 2-4 mm/year, consequently the return period of the fault was stimulated 2930 years.

**Figure 1. General trend and localization of South Mashhad fault taken from Google Earth.**

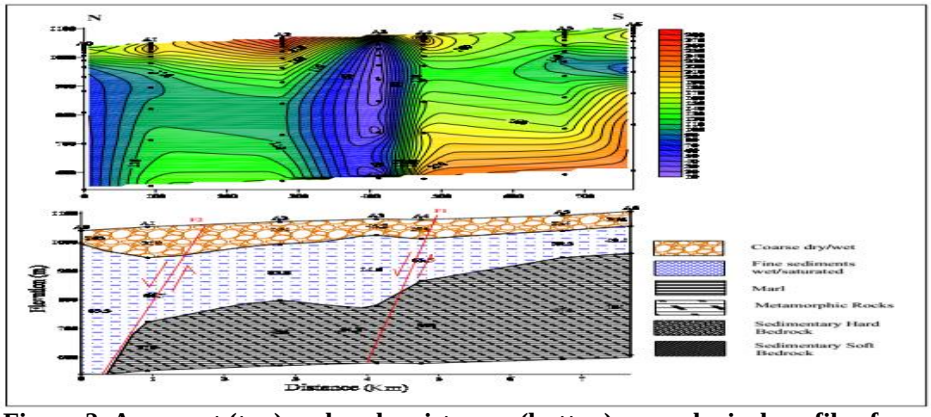


**Figure 2. Apparent (top) and real resistances (button) on geological profile of South Mashhad fault.**

## Results and discussion

To evaluate the avoidance fault zone, history, geometry and mechanism of the fault must be studied in detail [1, 2]. As the avoidance zone extends, the width of the faulting increases. For deep slip faults the area at risk develops over the hanging wall. When the fault is exposed by a curvature form, the width of fault extends towards the center of the curve. If sufficient information is available, the avoidance zone of the fault becomes more limited in width and vice versa. If the fault is well investigated, the minimum faulting zone is estimated 10 m. The minimum recommended

setback is 20 m distance from avoidance zone. This zone increases for reverse fault but decreases to lower value for normal and strike slip faults.

The study shows that South Mashhad fault is a right-lateral strike-slip fault with normal component that clearly passes through the Quaternary alluvial fans in South Mashhad. The uppermost right-lateral displacement of the fault occurred in the alluvial fans of eastern areas including Torogh (1300 m), Chehel-bazeh (1000 m) and Zoshk (600 m). The main reason for such displacement is younger alluvial fans and deposited sediments which occurred due to the normal component of the fault.

To estimate the fault setback, the geo-electrical data were interpreted. Also, four geomagnetic data series perpendicular to the fault direction were prepared. Using microtermore array method, three profiles perpendicular to the fault were run in east and west of Mashhad city and the direction of fault were exactly determined.

**Conclusions**

Based on the obtained results, the calculated avoidance zone for hanging wall and foot wall are proposed 80 and 70 m, respectively. The rate of displacement (74 cm) has been obtained according to the length of river dislocation which varies from 600 to 1300 m (950 m in average). Imagining the period of activity to be 1.6 Ma (Quaternary), the rate of movement for the fault is calculated 0.59 mm/year. Finally, the fault is distinguished as type II and construction in the fault zone is limited to only one-floor structures made with light building materials (e.g. wood frames).

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