



# An Overview of the Seismic Activity in Behbahan City, Southwest Iran

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## ABSTRACT

*This study examines the seismic activity and hazards in Behbahan City, southwestern Iran, situated within the seismically active Zagros Fold-Thrust Belt. Historical earthquakes, including devastating events in 1052 and 1085 AD, highlight the region's vulnerability. The area is characterized by ongoing crustal shortening due to the Arabian-Eurasian plate convergence, with several active faults, such as the Behbahan, Aghajari, and Arjan faults, posing significant threats. Analysis of regional seismotectonic frameworks reveals that Behbahan is consistently classified as a high-seismic-hazard zone, with potential for earthquakes exceeding magnitude 7.0. Our fault analysis identifies the Behbahan Fault as posing the highest immediate risk, with an estimated moment magnitude of 7.35 at a distance of 8.4 km from the city. The study recommends microzonation studies, retrofitting of vulnerable structures (especially unreinforced masonry buildings), implementation of early-warning systems, and the development of revised peak ground acceleration (PGA) maps. Multi-disciplinary research integrating InSAR, paleoseismology, and geotechnical data is crucial for refining hazard assessments and mitigating future earthquake impacts in this historically significant and densely populated region.*

## Keywords:

*Seismic hazard, Seismic risk, Active faults, Maximum magnitude of earthquakes.*



## 1. Introduction

Earthquakes have long been a leading cause of casualties and extensive financial losses in Iran, a country situated on the seismically active Alpine-Himalayan belt. With the ongoing expansion of urbanization and increasing construction activities near active fault zones, the risk posed by earthquakes is steadily rising, particularly in regions such as Behbahan. This growing threat is compounded by the proximity of new developments to major faults, elevating the potential for catastrophic outcomes in the event of a significant seismic event. Historical records underscore the destructive impact of past earthquakes in the Behbahan region. Notably, devastating earthquakes in 1052 and 1085 AD, with estimated magnitudes of 6.8 and 5.8 on the Local scale, respectively, led to the destruction of the ancient city of Arjan and resulted in significant loss of life. Chroniclers such as Ibn Athir documented the severe damage inflicted on Arjan and Izeh (formerly known as Idhaj) during these events, including widespread building collapse, fatalities, and even the fracturing of the northern Khayiz mountain, which exposed stair-like gypsum structures. These earthquakes are believed to have played a major role in the destruction of vital irrigation and agricultural infrastructure in Arjan, contributing to the city's subsequent decline in population and commercial significance. It is suggested that the initial serious damage to Arjan's twin bridges occurred during this period, with their complete destruction following in subsequent years. Modern studies of historical earthquakes corroborate the occurrence and devastating effects of these seismic events, which collectively led to widespread mortality, urban destruction, and the loss of critical infrastructure. Today, Behbahan remains highly vulnerable to seismic hazards due to the presence of numerous active faults in its vicinity, including the Aghajari, Behbahan, Arjan, and Mishan faults. Over the past decades, the region has experienced frequent earthquakes, and seismic zoning studies consistently classify Behbahan as an area of high seismic potential. This underscores the urgent need for careful planning and implementation of earthquake-resistant construction practices to mitigate future risks in this densely populated and historically significant region.

## 2. Study area

Seismically active zone shaped by ongoing tectonic compression. The collision of these plates has deformed the plateau's relatively weak crust, forming prominent fold-and-thrust belts such as the Zagros Mountains in the west, the Alborz and Kopeh Dag ranges in the north and northeast, and the Makran accretionary wedge in the southeast [1-5]. These structures remain geodynamically unstable, driving persistent seismic activity across Iran's mountainous regions, particularly in the Zagros fold-thrust belt [6-11]. The Zagros Mountains, formed by the northward motion of the Arabian Plate against Central Iran at  $\sim 2-3$  cm/year, exhibit complex seismotectonic behavior. In western Zagros, ductile evaporite layers (e.g., Hormuz salt) facilitate aseismic creep, leading to frequent moderate-magnitude earthquakes ( $M_w$  4-6) with short recurrence intervals [12]. Conversely, eastern Zagros experiences higher seismic strain due to the combined influence of the Arabian Plate's oblique convergence and the Indian Plate's northward subduction beneath Makran. This eastward increase in activity is reflected in Behbahan's seismicity, located near the transition zone between compressional and transpressive regimes [13-17]. Centered at coordinates  $30.5942^\circ\text{N}$ ,  $50.2375^\circ\text{E}$ , the  $400 \times 400$  km study area surrounding Behbahan lies within the Zagros foreland fold belt, characterized by the Mountain Front Fault and subsidiary structures like the Arjan and Aghajari faults. Over the past 35 years, the region has recorded 42 earthquakes  $\geq M_w$  4, underscoring its high seismicity. Historical accounts, including Ibn Athir's chronicles, document catastrophic earthquakes in 1052 and 1085 CE that destroyed Arjan's infrastructure and triggered mass casualties [18].



The Zagros' evaporite-rich stratigraphy promotes shallow-focus earthquakes (5-15 km depth) with limited surface rupture but high damage potential. While large-magnitude events ( $M_w > 7$ ) remain rare due to energy partitioning across multiple faults, moderate earthquakes ( $M_w 5-6.5$ ) pose significant risk to Behbahan's urban and infrastructure development [19-20]. The 21st-century expansion of settlements near active faults exacerbates vulnerability, mirroring the historical pattern of seismic disasters in Arjan [21-28]. This tectonic configuration highlights the urgent need for site-specific seismic zonation and retrofitting of critical infrastructure in Behbahan to mitigate future earthquake impacts [29-32].

Contextual synthesis from provided geological descriptions and tectonic principles (no direct citations available for specific seismological parameters) [33-35]. For precise fault mechanics and recurrence intervals, consult region-specific studies (e.g., Berberian, 2014; Talebian & Jackson, 2004).

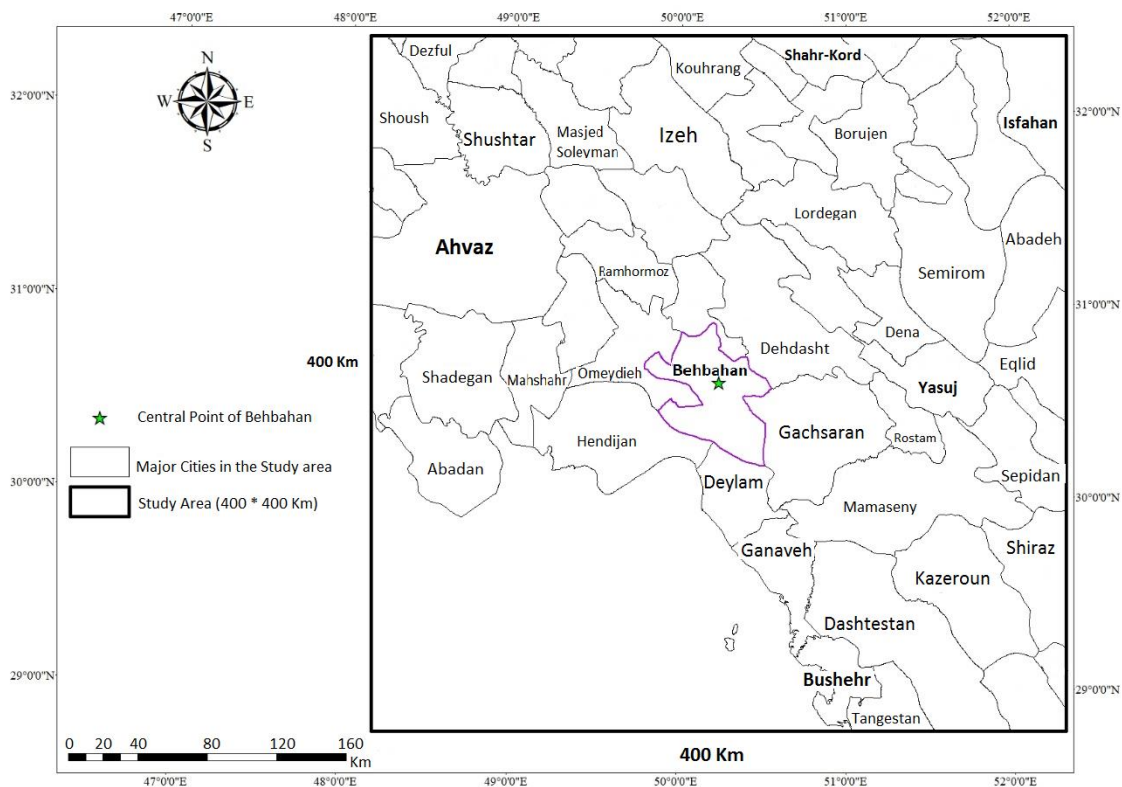


Figure 1. Map of the study area with dimensions of 400\*400 km centered on Behbahan.

Behbahan is situated in the southeastern sector of Khuzestan Province, Iran, spanning between  $49^{\circ}47'E$  to  $50^{\circ}33'E$  longitude and  $30^{\circ}10'N$  to  $30^{\circ}56'N$  latitude [36-40]. The city occupies a piedmont zone at an elevation of 320–350 meters above mean sea level, nestled within the southwestern foothills of the Zagros Mountains [41-46]. According to the 2016 National Census, Behbahan's urban population is 122,604 inhabitants, with a municipal area of 22.3 km<sup>2</sup> [47-50]. Located 200 km southeast of Ahvaz (the provincial capital) and 1,180 km southwest of Tehran, the city serves as a regional hub within the Zagros foreland basin [51-54].

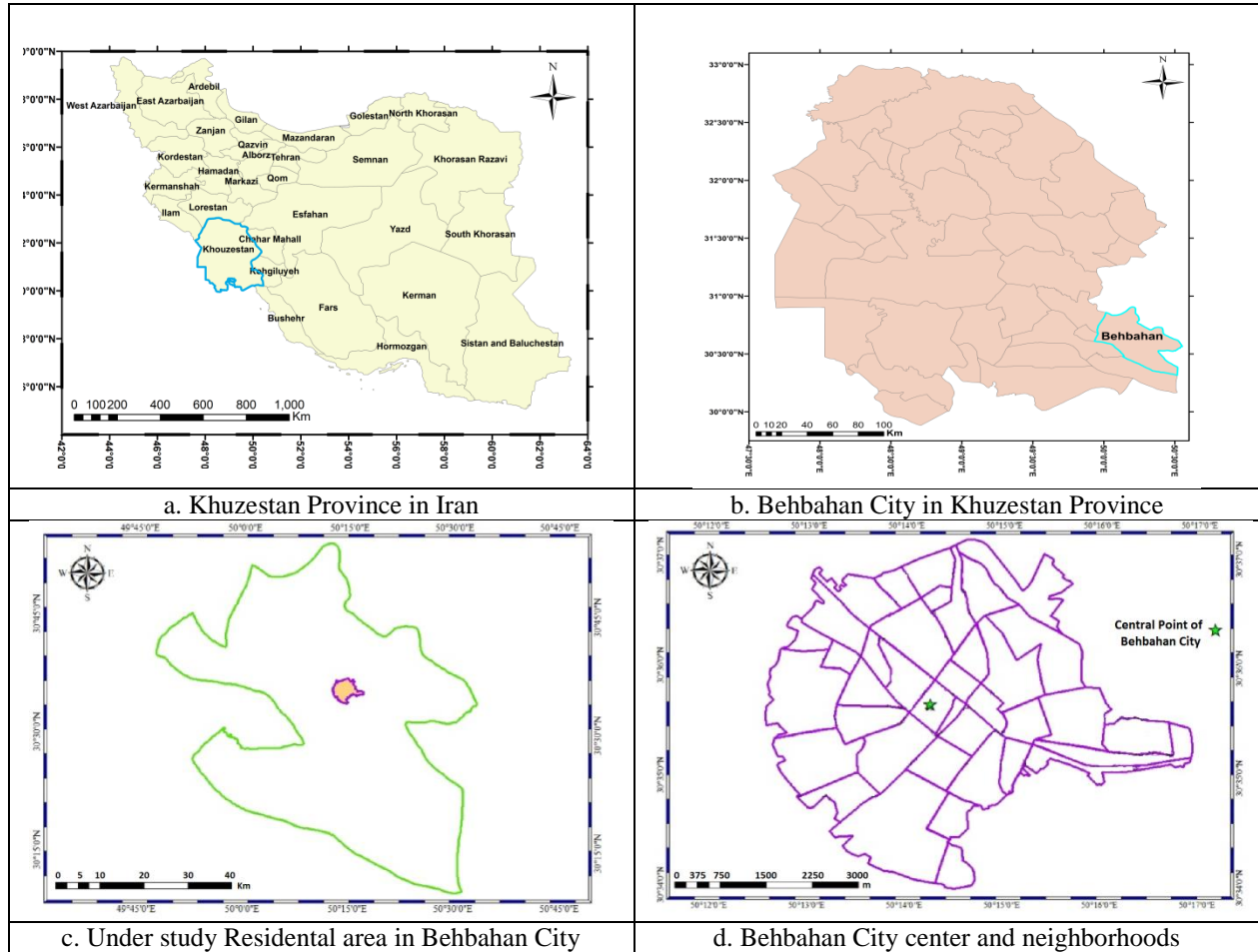


Figure 2. Geographical location of Behbahan

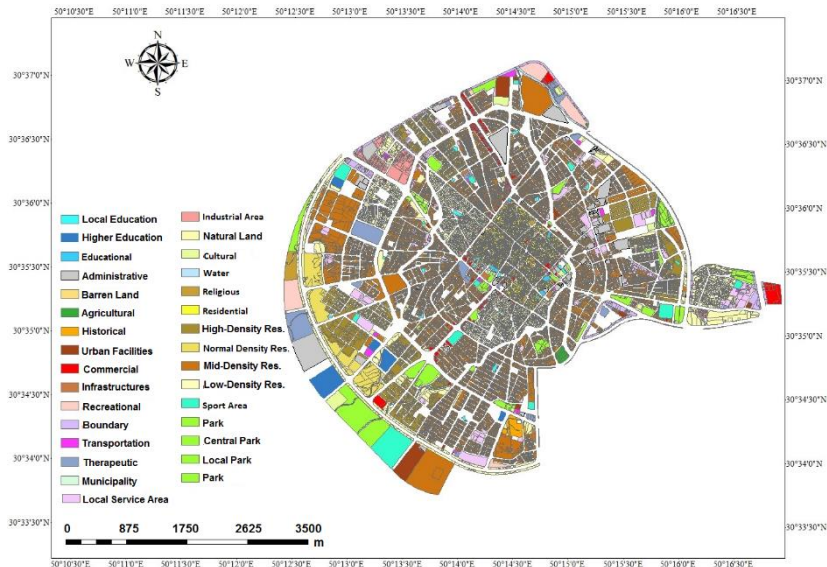


Figure 3. Land use map of Behbahan city



Khuzestan Province exhibits a dual geological structure comprising Tertiary-aged mountainous formations and Quaternary alluvial plains. The province's lowlands, extending from the Zagros foothills to the Persian Gulf, display a sedimentological gradient transitioning from coarse-grained conglomerates in the north to fine-grained clay-silt deposits in the south. This depositional system is primarily shaped by fluvial processes of the Karun, Dez, Karkheh, and Jarrahi rivers, which have formed terraces, sand hills, and floodplains composed of alternating clay, silt, sand, and sporadic gypsum layers. Behbahan, situated within this framework, rests on Quaternary non-cohesive sediments derived from the erosion of the Bakhtyari Conglomerate and Aghajari marls. Geomorphologically, the city encompasses both piedmont zones and plains, with prominent mountain ranges such as the Khaiz (1,536 m) and Talerish anticlines dominating its northern periphery. The Khaiz Mountain, the highest elevation in the region, exemplifies the NW-SE trending folds characteristic of the Zagros' southwestern deformation front, reflecting ongoing tectonic compression. Behbahan's location on Quaternary deposits adjacent to active fault systems underscores its exposure to seismic hazards, necessitating detailed geological hazard zonation studies to mitigate risks associated with urban expansion and infrastructure development.

### 3. Behbahan in Iran's different Seismotectonic Zoning

Behbahan falls within multiple seismotectonic zoning frameworks of Iran, including classifications by Abdalian (1963), Berberian (1976), Norouzi (1976), Nogol-Sadat (1993), Pourkermani and Asadi (1995), Tehran Padir Consulting Engineers (1996), National Committee of Large Dams (1996), Tavakoli and Ghafouri-Ashtiani (1999), and others. Below is a concise overview of key classifications:

#### 1- Berberian's Classification (1976)

Berberian identified four primary seismotectonic provinces: the *Active Folded Zagros Belt*, *Central Iran*, *Alborz Mountains*, and *Kopeh Dagh Mountains*. Behbahan lies within the Zagros Fold-Thrust Belt, characterized by ongoing crustal shortening due to Arabian-Eurasian plate convergence [55-60].

#### 2-Norouzi's Classification (1976)

Norouzi divided Iran into 23 seismotectonic provinces. Behbahan is part of the 6th province (Zagros Range), which exhibits the shortest recurrence intervals for small-to-moderate earthquakes ( $\leq M_w 5.6$ ) due to frequent release of strain energy along shallow thrust faults [61].

#### 3-National Zoning of Relative Earthquake Hazard (Urban Studies Center of Iran):

This framework divides Iran into 10 seismic zones. Khuzestan Province, including Behbahan, is categorized under the Zagros Fold-Thrust and Zagros Foothills (Dezful Embayment) subgroups. The boundary between these subgroups is defined by the Mountain Front Flexural Fault, a major structure responsible for large-magnitude earthquakes [62-65].

#### 4-Pourkermani and Asadi's Classification (1995)

Iran is divided into 27 seismotectonic provinces based on seismic activity between 1900–1992. Behbahan, Ahvaz, and Khorramshahr are located in Province 8 (Zagros Folded Belt), classified as a semi-active seismic zone with moderate earthquake potential ( $M_w \leq 7.0$ ) [62].

#### 5-Tehran Padir Consulting Engineers' Classification (1996):

This system identifies 20 seismotectonic units within seven broader geological-tectonic divisions. Behbahan falls under Unit 13, with seismic parameters derived from historical earthquakes (680–1889 CE) and instrumental records (1900–1995).

#### 6-Iran's Seismic Code (Standard 2800)



Behbahan is classified within Zone 4 (high relative seismic hazard) of Iran's Seismic Code Standard 2800 (4th Edition), necessitating a base seismic coefficient of 0.3g for pseudo-static design calculations<sup>[^]</sup>. This classification reflects its position in the Zagros Fold-Thrust Belt, where active faults like the Mountain Front Fault, Arjan Fault, and Aghajari Anticline contribute to elevated seismic risk. For comprehensive details and maps of these classifications, refer to Chapter 7 of "Applied Seismotectonics" by Mehran Arian [43].

#### 4. Methodology

A precise and complete identification of Quaternary faults in the project area is the first step in studying the seismic hazard of tectonics and faulting in the project area. Young major faults with a length of more than 10 km within a radius of 200 km around the Behbahan City have been studied [66]. The most important characteristics of the identified and investigated faults in this area are presented in Table 1. Where M is obtained by averaging relations 1 to 4 of Norouzi, Wells and Coppersmith, Mohajer and Norouzi, and Bonilla et al [67-69].

$$M = ((\log L + 0.1261)/0.675) \quad (1)$$

$$M = 5.08 + 1.16 \log L \quad (2)$$

$$M = 5.4 + \log L \quad (3)$$

$$M = 6.04 + 0.708 \log L \quad (4)$$

#### 5. Results and discussion

Based on the analyses performed, the results are shown in Table 1. In this table  $M_{ave}$  is average estimated moment magnitude ( $M_s$ ) for potential earthquakes. UTM Coordinates is Provided in WGS84 datum (Zone 39N for most entries). Type shows the Fault kinematics (reverse, strike-slip, or oblique). Trend pointed dominant fault orientation (e.g., NW-SE aligns with Zagros structural grain). Distance is the minimum distance from Behbahan city center to fault trace. Fault Length is the critical parameter for seismic hazard calculations (longer faults  $\rightarrow$  higher  $M_{max}$ ). in this table, Behbahan Fault (No. 196) poses the highest immediate risk at 8.4 km ( $M \approx 7.35$ ). Lahbari Fault (No. 117) has the longest trace (249 km) and highest  $M \approx 7.89$ . Most faults exhibit NW-SE reverse/oblique slip, consistent with Zagros shortening.

**Table 1.** Information on Faults Around Behbahan

| $M_{ave}$ | UTM End Point (X,Y)         | UTM Start Point (X,Y)       | Distance to Behbahan (km) | Fault Length (km) | Trend | Type                      | Fault Name  | No. |
|-----------|-----------------------------|-----------------------------|---------------------------|-------------------|-------|---------------------------|-------------|-----|
| 7.35      | (463560.3592, 3373895.328)  | (409431.1378, 3425846.3986) | 8.4                       | 78.8              | NW-SE | Reverse/Thrust            | Behbahan    | 196 |
| 7.26      | (416889.4507, 3421544.3571) | (461767.3174, 3379395.0999) | 11.0                      | 65.2              | NW-SE | Third-Order Fault         | Tashan      | 14  |
| 7.77      | (405774.8917, 3382276.3206) | (381901.2411, 3572638.4253) | 21.1                      | 192.7             | N-S   | Right-Lateral Strike-Slip | Izeh        | 191 |
| 7.52      | (430844.1755, 3352350.8349) | (356605.0475, 3433757.6118) | 23.7                      | 113.1             | NW-SE | Reverse/Thrust            | Aghajari    | 18  |
| 6.69      | (441179.7859, 3404191.0409) | (456466.646, 3392898.244)   | 24.0                      | 19.3              | NW-SE | Reverse/Thrust            | Baba Khaneh | 15  |
| 7.40      | (524495.9607, 3336813.8123) | (455582.7461, 3386578.8147) | 28.7                      | 87.2              | NW-SE | Reverse/Thrust            | Mishan      | 11  |



| M_ave | UTM End Point (X,Y)         | UTM Start Point (X,Y)       | Distance to Behbahan (km) | Fault Length (km) | Trend | Type                            | Fault Name      | No. |
|-------|-----------------------------|-----------------------------|---------------------------|-------------------|-------|---------------------------------|-----------------|-----|
| 7.52  | (465014.2682, 3306922.9553) | (383120.9114, 3371489.1226) | 44.7                      | 113.5             | NW-SE | Reverse/Thrust                  | Rag Sefid       | 17  |
| 7.87  | (399090.4098, 3425725.5311) | (241462.7904, 3594445.8699) | 49.4                      | 237.2             | NW-SE | Approximate/Hidden/Inferred     | Ramhormoz       | 19  |
| 7.44  | (509354.9284, 3256664.4118) | (443648.0198, 3315657.9735) | 71.2                      | 95.9              | NW-SE | Approximate/Hidden/Inferred     | M. F. F         | 100 |
| 7.89  | (393275.1028, 3453156.9668) | (220302.7465, 3612480.8009) | 76.1                      | 249.0             | NW-SE | Reverse/Thrust                  | Lahbari         | 117 |
| 6.69  | (408429.0949, 3481287.4168) | (420360.5796, 3466458.792)  | 81.8                      | 19.4              | NW-SE | Approximate/Hidden/Inferred     | M.F             | 75  |
| 6.80  | (517045.0371, 3398082.4198) | (502449.1174, 3417338.6218) | 82.0                      | 24.6              | NW-SE | Reverse/Thrust                  | Kuh-e Noh       | 140 |
| 6.86  | (329830.73, 3448647.2982)   | (347753.823, 3428278.9344)  | 90.3                      | 27.7              | NW-SE | Reverse/Thrust                  | Maroon          | 1   |
| 7.09  | (551025.1302, 3377085.1432) | (518603.4478, 3407267.8308) | 94.4                      | 45.4              | NW-SE | Reverse/Thrust                  | Sivak           | 139 |
| 6.71  | (396071.7244, 3495205.4199) | (409785.2206, 3481023.1039) | 97.6                      | 20.1              | NW-SE | Approximate/Hidden/Inferred     | M.F             | 79  |
| 6.93  | (383402.4493, 3475235.2571) | (359183.4678, 3495588.6713) | 100.3                     | 32.4              | NW-SE | Reverse/Thrust                  | Jarreh          | 195 |
| 6.58  | (418025.442, 3486935.52)    | (408573.2785, 3498680.9282) | 102.4                     | 15.3              | NW-SE | Reverse/Thrust                  | Seh Paran       | 121 |
| 6.73  | (415747.6676, 3493771.8031) | (408496.2974, 3513070.415)  | 109.5                     | 21.3              | NW-SE | Reverse/Thrust                  | Mangasht        | 10  |
| 6.86  | (379733.247, 3483684.1296)  | (365047.1011, 3506385.9334) | 109.5                     | 27.6              | NW-SE | Reverse/Thrust                  | Shah Neshin     | 122 |
| 7.48  | (566012.8814, 3400114.247)  | (517758.0954, 3485349.5879) | 112.9                     | 104.4             | NW-SE | Oblique (Reverse & Strike-Slip) | Dena            | 148 |
| 7.13  | (390394.6812, 3494457.1161) | (362401.3141, 3533000.8999) | 115.5                     | 49.9              | NW-SE | Reverse/Thrust                  | Mordehfel       | 6   |
| 6.71  | (546594.1436, 3408900.2626) | (562192.3913, 3397165.8848) | 122.1                     | 20.2              | NW-SE | Reverse/Thrust                  | Cheshmeh Chenar | 212 |
| 6.72  | (380439.6508, 3519681.3894) | (386319.2039, 3501246.3247) | 123.2                     | 20.8              | NW-SE | Reverse/Thrust                  | Sarakan-e Bala  | 126 |
| 7.38  | (490282.5487, 3504118.6111) | (421316.1184, 3538741.1583) | 124.0                     | 83.7              | NW-SE | Reverse/Thrust                  | Massan          | 9   |
|       |                             |                             |                           |                   |       |                                 |                 |     |
|       |                             |                             |                           |                   |       |                                 |                 |     |

Table 1. (Continued): Faults Around Behbahan

| M_ave | UTM End Point (X,Y)         | UTM Start Point (X,Y)       | Distance to Behbahan (km) | Fault Length (km) | Trend | Type                      | Fault Name | No. |
|-------|-----------------------------|-----------------------------|---------------------------|-------------------|-------|---------------------------|------------|-----|
| 7.56  | (548433.6896, 3275677.1061) | (552616.4004, 3396465.3939) | 124.4                     | 123.2             | N-S   | Right-Lateral Strike-Slip | Kazerun    | 198 |
| 7.04  | (458086.1751, 3508522.4229) | (428226.1944, 3532475.9111) | 125.8                     | 40.9              | NW-SE | Reverse/Thrust            | Bazoft     | 200 |
| 7.51  | (313386.3347, 3441170.8475) | (226920.2542, 3508615.5033) | 126.7                     | 110.7             | NW-SE | Reverse/Thrust            | Ahvaz      | 12  |
| 7.00  | (490105.2807, 3505163.3527) | (454991.928, 3512189.1859)  | 127.3                     | 37.6              | NW-SE | Reverse/Thrust            | Kermani    | 130 |
| 7.08  | (558082.2858, 3319404.0994) | (552308.4223, 3362427.4169) | 127.3                     | 44.6              | NW-SE | Remote Sensing Lineaments | -          | 146 |



| M_ave | UTM End Point (X,Y)         | UTM Start Point (X,Y)       | Distance to Behbahan (km) | Fault Length (km) | Trend | Type                      | Fault Name      | No. |
|-------|-----------------------------|-----------------------------|---------------------------|-------------------|-------|---------------------------|-----------------|-----|
| 7.56  | (548433.6896, 3275677.1061) | (552616.4004, 3396465.3939) | 124.4                     | 123.2             | N-S   | Right-Lateral Strike-Slip | Kazerun         | 198 |
| 7.04  | (458086.1751, 3508522.4229) | (428226.1944, 3532475.9111) | 125.8                     | 40.9              | NW-SE | Reverse/Thrust            | Bazoft          | 200 |
| 7.09  | (592670.2542, 3395415.481)  | (555653.2807, 3406439.0792) | 130.5                     | 45.8              | NW-SE | Reverse/Thrust            | Chal Kalagh     | 133 |
| 6.61  | (397105.2073, 3530161.8646) | (406896.2149, 3516926.2145) | 133.5                     | 16.6              | NW-SE | Third-Order Fault         | Ab-e Rak        | 7   |
| 7.25  | (516407.3726, 3496857.405)  | (465342.7199, 3529100.4076) | 134.8                     | 64.0              | NW-SE | Reverse/Thrust            | Dopolitan       | 193 |
| 7.31  | (615547.8423, 3397663.5769) | (555427.2336, 3426521.3009) | 135.1                     | 71.7              | NW-SE | Reverse/Thrust            | Kuh Siah        | 211 |
| 6.94  | (581807.7866, 3415219.1782) | (553791.8452, 3431725.3803) | 135.3                     | 33.2              | NW-SE | Reverse/Thrust            | Bideh           | 217 |
| 7.18  | (506453.8186, 3533474.9935) | (523824.9803, 3482660.1392) | 137.7                     | 54.7              | NW-SE | Reverse/Thrust            | Sabzeh Kuh      | 8   |
| 6.61  | (303598.5083, 3448560.0286) | (291619.2107, 3459489.7058) | 138.8                     | 16.3              | NW-SE | Reverse/Thrust            | Ahvaz           | 72  |
| 6.65  | (575413.8226, 3418949.4455) | (559472.0696, 3426627.2187) | 139.0                     | 17.9              | NW-SE | Reverse/Thrust            | Taveh Siah      | 132 |
| 6.57  | (392043.8316, 3534526.6721) | (401488.1493, 3523080.8828) | 140.5                     | 15.0              | NW-SE | Third-Order Fault         | Farum           | 127 |
| 6.96  | (476034.799, 3532978.2643)  | (444455.7977, 3525255.4103) | 141.5                     | 34.2              | NW-SE | Reverse/Thrust            | Kordan          | 194 |
| 7.76  | (597172.9229, 3126142.4115) | (516559.734, 3273493.2529)  | 143.0                     | 185.9             | NW-SE | Reverse/Thrust            | Borazjan        | 119 |
| 6.57  | (311702.6806, 3499742.1571) | (322034.0828, 3488769.3317) | 147.6                     | 15.1              | NW-SE | Third-Order Fault         | Avafi           | 123 |
| 6.70  | (580954.7563, 3373371.5302) | (575820.3222, 3391976.0204) | 149.1                     | 20.0              | NW-SE | Reverse/Thrust            | Kakan           | 138 |
| 6.93  | (389626.5382, 3529516.2939) | (366121.2892, 3551237.6022) | 149.4                     | 32.7              | NW-SE | Reverse/Thrust            | M.F             | 2   |
| 6.91  | (515888.8141, 3510935.5079) | (535837.879, 3487621.9628)  | 149.7                     | 31.1              | NW-SE | Right-Lateral Strike-Slip | Mourchegan      | 129 |
| 7.37  | (633203.8943, 3324519.3679) | (578330.2884, 3381997.674)  | 151.5                     | 82.2              | NW-SE | Reverse/Thrust            | H. Z            | 74  |
| 6.90  | (569688.5136, 3471568.3719) | (543757.3907, 3482882.2634) | 152.5                     | 30.1              | NW-SE | Reverse/Thrust            | Semirom         | 137 |
| 7.78  | (500468.5761, 3527321.8017) | (371318.3215, 3650465.1952) | 153.7                     | 195.4             | NW-SE | Reverse/Thrust            | Ardal           | 147 |
| 7.22  | (589947.3687, 3253228.0712) | (556183.5509, 3300315.6183) | 154.5                     | 59.8              | NW-SE | Remote Sensing Lineaments | -               | 144 |
| 6.95  | (345771.0635, 3521172.1448) | (322884.6668, 3542160.0992) | 158.6                     | 33.7              | NW-SE | Reverse/Thrust            | Masjed Soleiman | 192 |
| 6.94  | (602642.9696, 3415315.0319) | (577663.1704, 3436098.2581) | 159.2                     | 33.1              | NW-SE | Reverse/Thrust            | Janga           | 206 |
| 6.80  | (578983.9901, 3437182.225)  | (571930.2438, 3460383.7111) | 159.6                     | 24.7              | NW-SE | Reverse/Thrust            | Hana            | 136 |
| 7.85  | (462533.8767, 3544767.5624) | (299252.9831, 3683207.6554) | 160.8                     | 227.5             | NW-SE | Reverse/Thrust            | Zard Kuh        | 197 |



**Table 1.** (Continued): Faults Around Behbahan

| M_ave | UTM End Point (X,Y)         | UTM Start Point (X,Y)       | Distance to Behbahan (km) | Fault Length (km) | Trend | Type                            | Fault Name    | No. |
|-------|-----------------------------|-----------------------------|---------------------------|-------------------|-------|---------------------------------|---------------|-----|
| 6.88  | (594853.6547, 3420807.6998) | (577029.3718, 3443127.5042) | 161.0                     | 29.1              | NW-SE | Reverse/Thrust                  | Kuhe-e Aqdagh | 135 |
| 7.54  | (637450.3341, 3419974.2835) | (546652.3091, 3492552.407)  | 161.0                     | 119.0             | NW-SE | Reverse/Thrust                  | M.Z.R         | 16  |
| 7.04  | (548995.0677, 3500409.1526) | (516734.2234, 3524449.6823) | 163.2                     | 40.8              | NW-SE | Reverse/Thrust                  | M.Z.R         | 214 |
| 7.32  | (407152.4539, 3547215.048)  | (360758.3652, 3601467.4337) | 163.5                     | 74.2              | NW-SE | Third-Order Fault               | Mafarun       | 199 |
| 7.10  | (542906.1255, 3515390.7698) | (501735.2135, 3536199.7516) | 168.3                     | 46.4              | NW-SE | Reverse/Thrust                  | M.Z.R         | 215 |
| 7.80  | (501885.0212, 3536203.6745) | (362116.256, 3675559.2751)  | 168.9                     | 204.3             | NW-SE | Reverse/Thrust                  | M.Z.R         | 216 |
| 7.18  | (362958.8767, 3546057.7984) | (331298.0049, 3575810.6773) | 173.4                     | 54.5              | NW-SE | Reverse/Thrust                  | Andakan       | 210 |
| 7.60  | (364123.5763, 3650426.7046) | (442529.1496, 3564481.7751) | 180.1                     | 132.9             | NW-SE | Reverse/Thrust                  | Solaghan      | 73  |
| 7.56  | (620888.3598, 3205167.1398) | (593972.879, 3317045.8737)  | 180.3                     | 122.7             | N-S   | Oblique (Reverse & Strike-Slip) | Karehbas      | 149 |
| 6.39  | (600349.4432, 3331154.6213) | (602997.4484, 3321629.6243) | 181.6                     | 10.3              | NW-SE | Remote Sensing Lineaments       | -             | 70  |
| 6.71  | (360447.2059, 3573275.922)  | (374886.2103, 3560012.0737) | 182.7                     | 20.3              | NW-SE | Reverse/Thrust                  | Dasht-e Gol   | 208 |
| 7.08  | (599713.423, 3321093.8943)  | (632375.8776, 3293166.1819) | 184.2                     | 44.6              | NW-SE | Reverse/Thrust                  | Qalat         | 134 |
| 7.67  | (382301.432, 3648953.8589)  | (499553.8066, 3556530.5913) | 185.8                     | 154.2             | NW-SE | Second-Order Fault              | Shahr-e Kord  | 3   |
| 6.69  | (379304.2335, 3580215.9046) | (393274.1968, 3567689.3331) | 185.9                     | 19.5              | NW-SE | Reverse/Thrust                  | Susan         | 209 |
| 7.14  | (641856.9812, 3291765.4281) | (602997.4484, 3321629.6243) | 187.1                     | 50.4              | NW-SE | Reverse/Thrust                  | Kelestan      | 13  |
| 7.44  | (299593.0185, 3630147.8863) | (362562.6658, 3561188.4851) | 187.7                     | 96.0              | NW-SE | Approximate/Hidden/Inferred     | M.F           | 83  |
| 6.70  | (628408.8215, 3375963.363)  | (614711.0134, 3389546.4447) | 187.9                     | 20.0              | NW-SE | Remote Sensing Lineaments       | -             | 71  |
| 6.60  | (378167.7892, 3572090.9266) | (367379.1145, 3583351.6023) | 193.4                     | 16.1              | NW-SE | Reverse/Thrust                  | Chal-e Munar  | 125 |
| 7.45  | (688862.5864, 3271409.054)  | (610306.6918, 3323020.3175) | 193.6                     | 96.8              | NW-SE | Reverse/Thrust                  | Katah         | 190 |
| 6.95  | (618777.229, 3463259.4713)  | (596872.8042, 3486821.6342) | 198.2                     | 33.6              | NW-SE | Reverse/Thrust                  | Cher cher     | 128 |
| 7.61  | (558879.4761, 3082864.6204) | (507617.26, 3202800.6769)   | 199.2                     | 136.2             | NW-SE | Approximate/Hidden/Inferred     | Z. F. F       | 150 |

Behbahan lies within the Zagros Fold-Thrust Belt, a seismically active zone resulting from the oblique convergence of the Arabian and Eurasian plates. Dominant NW-SE trending reverse/thrust faults (e.g., Behbahan, Aghajari) accommodate crustal shortening, while subordinate strike-slip faults (e.g., Mourchegan, Karehbas) reflect stress partitioning. Seismic Parameters and Design Implications Dominant Magnitude Range is  $M \approx 6.5-7.8$ , with  $M \geq 7.5$  possible on faults  $>150$  km (e.g., Zard Kuh). Possible discrepancies in this regards are:

1-Fault Lengths: Table values (e.g., Aghajari: 113.1 km) often represent segments, not full fault systems.



2-Magnitude Estimates:  $M_{ave}$  assumes partial rupture; full rupture (e.g., Zard Kuh) could exceed  $M \approx 8.0$ .

3-Hidden Faults (e.g., M.F, Ramhormoz): Poor surface expression complicates hazard mapping. so, we can propose some recommendations for risk mitigation, including microzonation studies, retrofitting (focus on unreinforced masonry (URM) structures near Behbahan Fault) , early-warning systems , and revised PGA maps.

As mentioned, the seismicity of Behbahan City is primarily influenced by regional tectonic processes. In the central Zagros region, the shortening rate is estimated at 5–10 mm per year, reflecting ongoing crustal convergence. The Behbahan Fault itself may be partially locked, allowing tectonic strain to accumulate over time. Historical records indicate significant seismic events, such as those in 1052 CE and 1085 CE (with estimated magnitudes around 6.8), which demonstrate the area's potential for recurrent high-energy earthquakes. More recently, microseismic activity—such as the magnitude 4.4 events recorded between 2021 and 2025—confirms that active crustal deformation continues in the region.

Behbahan's seismic risk is dominated by NW-SE reverse faults with  $M \geq 7.5$  potential. While Standard 2800's 0.3g PGA suffices for general design, site-specific spectra are critical near Behbahan, Aghajari, and Zard Kuh faults. Multi-disciplinary studies integrating InSAR, paleoseismology, and geotechnical data are urgently needed to refine hazard assessments.

## 6. Conclusion

The known faults in the Behbahan region and its surrounding areas predominantly lie along the mountain-front boundaries, marking the transition between the Zagros Fold-Thrust Belt and alluvial plains. These faults play a critical role in accommodating crustal shortening driven by the ongoing Arabian-Eurasian plate convergence. However, significant gaps persist in precise age dating and seismicity records for these faults, a limitation that extends to fault databases across Iran, complicating seismic hazard assessments. The dominant fault mechanisms in the Behbahan area are reverse/thrust systems (e.g., Behbahan, Aghajari, Ramhormoz), often accompanied by a major compressional component. Reverse faults, compared to strike-slip or normal faults, release higher seismic energy due to their compressional nature, resulting in elevated horizontal peak ground accelerations (PGA). This characteristic renders them capable of generating destructive, high-magnitude earthquakes (e.g., potential  $M \geq 7.2$  for the Behbahan Fault), as evidenced by historical events such as the 1052 CE and 1085 CE earthquakes ( $M \approx 8.5-8.6$ ) that devastated the region. Reverse faults in the region can produce strong ground motions exceeding 0.35g PGA near urban centers like Behbahan, surpassing standard building code recommendations. Recurrence intervals for large earthquakes remain poorly constrained, but historical and paleoseismic data suggest a high probability of future high-energy events. Urgent Needs for the region are advanced dating techniques (e.g., cosmogenic nuclide analysis) to constrain fault activity rates; dense seismic networks to improve microseismicity monitoring and rupture forecasting; and Site-specific ground motion models integrating fault directivity and basin amplification effects. the Behbahan region's tectonic setting, dominated by active reverse faults with high seismic energy potential, underscores the necessity for prioritized retrofitting of critical infrastructure and revised urban planning policies to mitigate earthquake risks. Addressing data gaps in fault chronology and seismicity is imperative for reducing uncertainties in seismic hazard models.



## 7. References

- 1-Zolfegharifar, S. Y., & Bosak, M. (2016). Tectonic and Seismotectonics Survey in Behbahan. *Open Journal of Geology*, 6(2), 103-108. <https://doi.org/10.4236/ojg.2016.62010>
- 2-Zarunizadeh, Z., Motaghi, K., & Rahimi, H. (2024). Attenuation of High-Frequency Seismic Waves in NW Iran. *Pure and Applied Geophysics*, 181(6), 1811-1829. <https://doi.org/10.1007/s00024-024-03496-y>
- 3- Berberian, M. AN ExPLANAToRY NOTE ON THE FRs SEISMOTECTONIC MAP OF IRAN; A SEISMO-TECTONIC REVIEW OF THE <https://www.researchgate.net/publication/285021929>
- 4- Barjasteh, A. (2019). Influence of geological structure on dam behavior and case studies. In *Dam engineering*. Intech Open. <https://doi.org/10.5772/intechopen.78742>
- 6- Rahimi, M., & Riahi, M. A. (2020). Static reservoir modeling using geostatistics method: a case study of the Sarvak Formation in an offshore oilfield. *Carbonates and Evaporites*, 35(2), 62. <https://doi.org/10.1007/s13146-020-00598-1>
- 7- McEvelly, T. V., & Razani, R. (1973). The Qir, Iran earthquake of April 10, 1972. *Bulletin of the Seismological Society of America*, 63(1), 339-354. <https://doi.org/10.1785/BSSA0630010339>
- 8- Hejazi, S. J., Sharifi, A., & Arvin, M. (2022). Assessment of social vulnerability in areas exposed to multiple hazards: a case study of the Khuzestan Province, Iran. *International Journal of Disaster Risk Reduction*, 78, 103127. [10.1016/j.ijdrr.2022.103127](https://doi.org/10.1016/j.ijdrr.2022.103127)
- 9- Berberian, M., & Tchalenko, J. (1976). Earthquakes of the southern Zagros (Iran): Bushehr region. *Geol. Surv. Iran*, 39, 343-370. <https://www.researchgate.net/publication/284778538>
- 10- Arvin, M., Beiki, P., Hejazi, S. J., Sharifi, A., & Atashafrooz, N. (2023). Assessment of infrastructure resilience in multi-hazard regions: A case study of Khuzestan Province. *International Journal of Disaster Risk Reduction*, 88, 103601. <https://doi.org/10.1016/j.ijdrr.2023.103601>
- 11- Sherkati, S., & Letouzey, J. (2004). Variation of structural style and basin evolution in the central Zagros (Izeh zone and Dezful Embayment), Iran. *Marine and petroleum geology*, 21(5), 535-554. <https://doi.org/10.1016/j.marpetgeo.2004.01.007>
- 12- Eftekhari, N. , Motaghd, S. , Emadali, L. and Sayyadpour, H. (2025). Artificial Statistical Method to Estimating Seismicity Parameters for Ahvaz City Using a Stochastic Synthetic Seismic Catalog. *Journal of Seismology and Earthquake Engineering*, (), -. <https://doi.org/10.48303/jsee.2025.2041574.1124>
- 13- Motaghd, S. and fakhriyat, A. reza (2025). Uncertainties in seismic hazard assessment of Metropolitan Tehran. *International Journal of Reliability, Risk and Safety: Theory and Application*, (), -. <https://doi.org/10.22034/ijrrs.2024.494580.1179>
- 14- Motaghd, sasan, Emadali, Loftollah, (2025). Performance-Based Methodology for Seismic Design and Evaluation of Bridges, *Advance Researches in Civil Engineering*, <https://doi.org/10.30469/arce.2025.511561.1084>
- 15- Lotfollah Emadali, Mozhgan Mehrpak, Sasan Motaghd, Nasrollah Eftekhari, Determination of displacement components of Sisakht earthquake (M 5.4) by Radar Interferometry (InSAR), *Bulletin of Earthquake Science and Engineering – BESE*, <http://doi:10.48303/bese.2025.2036596.1193>
- 16- Abiari A, Motaghd S, Sayyadpour H, et al. Seismic fragility evaluation of box deck concrete bridge equipped with shape memory alloy under bi-directional earthquake loading. *Earthquake2025*;3(1):8253. <http://doi:10.59429/ear.v3i1.8253>



- 17- Motaghd S, shamsizadeh M, eftekhari N. Earthquake possibility space of Ahvaz city based on intuitionistic fuzzy theory. *Journal of Engineering Geology* 2024; 18 (3) :320-340. <http://jeg.khu.ac.ir/article-1-3126-fa.html>
- 18- Motaghd, S., Eftekhari, N., Nakhlian, A., Emadali, L., & Mahmoudian, H. (2024). Seismic Risk Analysis In The Behbahan Urban Decay. *Safe City*, (), -. <https://doi:10.22034/ispdrc.2024.2036864.1122>
- 19- Bachmanov, D. M., Trifonov, V. G., Hessami, K. T., Kozhurin, A. I., Ivanova, T. P., Rogozhin, E. A., ... & Jamali, F. H. (2004). Active faults in the Zagros and central Iran. *Tectonophysics*, 380(3-4), 221-241. <https://doi.org/10.1016/j.tecto.2003.09.021>
- 20- Motaghd, S. and Zareii, Y. (2024). Drilling test, A review. *Advance Researches in Civil Engineering*, 6(1), 31-44 <https://doi:10.30469/arce.2024.476684.1079>
- 21- Motaghd, S., Mahmoodian, H., ri, S. (2024). Case Studies in Seismic Risk Assessment of Masonry Fire Station Buildings. *International Journal of Reliability, Risk and Safety: Theory and Application*, 7(2), 40-51. doi: 10.22034/IJRRS.2024.7.2.4 <https://doi:10.22034/ijrrs.2024.471909.1169>
- 22- Motaghd, S., & Mehrabi Moghaddam, A. (2024). Confidence level for Iranian Existing Moment Resisting RC Structures Based on Demand and Capacity Factored Design Method. *International Journal of Reliability, Risk and Safety: Theory and Application*, 7(1), 93-102. <https://doi:10.22034/IJRRS.2024.7.1.11>
- 23- Motaghd, S., Mohammadi, M., Eftekhari, N., Khazaea, M., SCP parameters estimation for catalogs with uncertain seismic magnitude values. *Acta Geophys.* (2024). <https://doi.org/10.1007/s11600-024-01404-5>
- 24- Soleimani, M., Mann, J., Shahsavani, H., & Shahbazi, A. (2012, September). Structural interpretation of east Dezful Embayment in Zagros fold-thrust belt by seismic sections. In *Istanbul 2012-International Geophysical Conference and Oil & Gas Exhibition* (pp. 1-4). Society of Exploration Geophysicists and The Chamber of Geophysical Engineers of Turkey.
- 25- Fakhriyat, A., Motaghd, S & Shahidzadeh, M. S. (2024). The necessity of modeling the column beam joint panel zone in reinforced concrete structures with behavioral degradation. *Amirkabir Journal of Civil Engineering*, 56(7), 3-3. <https://doi:10.22060/ceej.2024.22089.7900>
- 26- Motaghd, S., Eftekhari, N., asadian, A., Multi-Criteria Optimization of Durability Properties of Self-Compacting Concrete Using Artificial Intelligence, *Advance Researches in Civil Engineering* <https://doi:10.30469/arce.2024.451053.1073>
- 27- Motaghd, S., Rastegar, A., & Hosseini, S. A. (2024). Workability and compressive strength of self-compacting concrete containing rice husk ash from controlled and uncontrolled burning condition. *Concrete Research*, (), -. <https://doi:10.22124/jcr.2024.26208.1638>
- 28- Eftekhari N, Motaghd S, Emadali L, Sayyadpour H. Ranking of ground motion prediction equation for use in the seismic hazard analysis of Ahvaz city using data envelopment analysis. *Journal of Engineering Geology* 2022; 16 (2) :99-124 <http://jeg.khu.ac.ir/article-1-3083-fa.html>
- 29- Motaghd, S., Eftekhari, N., Emadali, L., & Sayyadpour, H. (2024). Revision of Ahvaz City seismic hazard analyzes according to the state of Ahvaz fault. *Advanced Applied Geology*, (), -. <https://doi:10.22055/aag.2024.44810.2405>
- 30- Motaghd, S., Mehrabi Moghaddam, A., & Moayyeri, N. (2023). Reliability of Iranian Existing Residential Reinforced Concrete Structures in Seismic Events. *International Journal of Reliability, Risk and Safety: Theory and Application*, (), -. <https://doi:10.22034/ijrrs.2023.419124.1138>



- 31- Motaghed, S., nakhlian, A., emadali, L., eftekhari, N., & mahmoudian, H. (2023). Seismic hazard assessment using arithmetic-weighted overlay method based on earthquake potential index (EPI), the southwestern Iran. *Iranian Journal of Remote Sensing & GIS*, (), -. [https:// doi: 10.48308/gisj.2023.229646.1133](https://doi.org/10.48308/gisj.2023.229646.1133)
- 32- Motaghed, S., Eftekhari, N., & Mohammadi, M, Khazae, M.. (2023) Logic tree branches' weights in the probabilistic seismic hazard analysis; the need to combine inter-subjective and propensity probability interpretations, *journal of seismology*, <https://doi.org/10.1007/s10950-023-10177-1>
- 33- Bou-Rabee, F., & VanMarcke, E. (2001). Seismic vulnerability of Kuwait and other Arabian Gulf countries: information base and research needs. *Soil Dynamics and Earthquake Engineering*, 21(2), 181-186.
- 34- Kazemifard, S., Motaghed, S. & Eftekhari, N. NDT prediction of self-compacting concrete strength based on maturity method. *Multiscale and Multidiscip. Model. Exp. and Des.* (2023). <https://doi.org/10.1007/s41939-023-00262-w>
- 35- Motaghed, sasan, Rastegar, Ali and Dadpour, Alireza, Evaluation of the effect of replacing cement with rice husk ash on self-compacting concrete properties, *Advance Researches in Civil Engineering* <https://doi.org/10.30469/arce.2023.410360.1061>
- 36- Motaghed, S., Eftekhari, N., khazae, M., & yousefi Dadras, E. (2023). Selection and Ranking the Ground Motion Prediction Equations for Tehran Region. *Journal of Structural and Construction Engineering*, (), -. [https:// doi: 10.22065/jsce.2023.393094.3088](https://doi.org/10.22065/jsce.2023.393094.3088)
- 37- Sasan Motaghed, Atalah Farhadi ghafi, Alireza dadpour, Investigating the effect of iron ore powder on fresh and hardened properties of self-compacting concrete, *Advance Researches in Civil Engineering*, [https:// doi: 10.30469/arce.2022.171456](https://doi.org/10.30469/arce.2022.171456)
- 38- Sasan Motaghed, Ahmad Reza Fakhriyat, A reliable method for determining the tapered minimum magnitude in a probabilistic seismic hazard analysis, *International Journal of Reliability, Risk and Safety: Theory and Application* [https:// doi: 10.30699/IJRRS.5.2.9](https://doi.org/10.30699/IJRRS.5.2.9)
- 39- Barjasteh, A. (2012). Salt tectonics impact on dam construction in Khuzestan Province of Iran. In *International Symposium on Dams for a Changing World*.
- 40- Motaghed, S., Khazae, M., Eftekhari, N., & Mohammadi, M. (2023). A non-extensive approach to probabilistic seismic hazard analysis. *Natural Hazards and Earth System Sciences*, 23(3), 1117-1124. <https://doi.org/10.5194/nhess-23-1117-2023>
- 41- Motaghed, S., nakhlian, A., emadali, L., eftekhari, N., & mahmudian, H. (2023). Determining the natural frequency of Behbahan city soil using microtremor data analysis. *Journal of Geography and Environmental Hazards*, (), -. [https:// doi: 10.22067/geoeh.2023.80563.1326](https://doi.org/10.22067/geoeh.2023.80563.1326)
- 42- Barzian, V., Motaghed, S., Mehrabi Moghaddam, A., Asghari Pari, S. A., & emadali, L. (2022). Investigation the effect of structural parameters uncertainty on the response of incremental dynamic analysis of intermediate steel moment resisting frame structures. *Journal of Structural and Construction Engineering*, 9(10), 175-195. [https:// doi: 10.22065/jsce.2022.311616.2612](https://doi.org/10.22065/jsce.2022.311616.2612)
- 43- Arian, M. (2015). Seismotectonic-Geologic Hazards Zoning of Iran. *Earth Sciences Research Journal*, 19(1), 7-13. [https:// doi: 10.15446/esrj.v19n1.40664](https://doi.org/10.15446/esrj.v19n1.40664)
- 44- Karimiparidari, S., Zaré, M., & Memarian, H. (2011, May). New seismotectonic zoning map of Iran. In *Proc. 6th Int. Conf. on Seismology and Earthquake Engineering (SEE6)*. <https://www.researchgate.net/publication/235902268>
- 45- Zare, M. (2017). Seismic hazard zoning in Iran: a state-of-the-art on the studies during four decades. *Journal of Seismology and Earthquake Engineering*, 19(2), 71-101. [https://www.jsee.ir/article\\_240762.html](https://www.jsee.ir/article_240762.html)



- 46- Nowroozi, A. A. (1976). Seismotectonic provinces of Iran. *Bulletin of the Seismological Society of America*, 66(4), 1249-1276. <https://doi.org/10.1785/BSSA0660041249>
- 47- Berberian, M., & Mohajer-Ashjai, A. (1977). Seismic risk map of Iran, a proposal. *Geol. Surv. Iran*, 40, 121-148. <https://www.researchgate.net/profile/Manuel-Berberian/publication/294872080>
- 48- Mehrabi Moghadam, A., Yazdani, A., Motaghed, S. (2022). Considering the Yielding Displacement Uncertainty in Reliability of Mid-Rise R.C. Structures. *Journal of Rehabilitation in Civil Engineering*, 10(3), 141-157. <https://doi.org/10.22075/jrce.2021.19660.1376>
- 49- Motaghed, S., Khazae, M. & Mohammadi, M. The b-value estimation based on the artificial statistical method for Iran Kope-Dagh seismic province. *Arab J Geosci* 14, 1461 (2021). <https://doi.org/10.1007/s12517-021-07970-y>
- 50- Jafari, M., Aflaki, M., Mousavi, Z., Walpersdorf, A., & Motaghi, K. (2023). Coseismic and post-seismic characteristics of the 2021 Ganaveh earthquake along the Zagros foredeep fault based on InSAR data. *Geophysical Journal International*, 234(2), 1125-1142. <https://doi.org/10.1093/gji/ggad127>
- 51- Ehsani, J., & Arian, M. (2015). Quantitative analysis of relative tectonic activity in the Jarahi-Hendijan basin area, Zagros, Iran. *Geosciences Journal*, 19, 751-765. <https://doi.org/10.1007/s12303-015-0016-3>
- 52- Motaghed, S., & fakhriyat, A. R. (2021). Modeling inelastic behavior of RC adhered shear walls in opensees. *Journal of Modeling in Engineering*, 18(63), 15-25. <https://doi.org/10.22075/jme.2020.18042.1740>
- 53- Motaghed, S., babadi, F., nil seresht, S., mirzaee ali abadi, M., asghari peri, S. A., & askari, M. (2020). Experimental evaluation of the effect of magnetic water on the fresh and hardened pervious concrete properties. *Journal of Transportation Infrastructure Engineering*, 6(3), 89-104. <https://doi.org/10.22075/jtie.2020.16243.1346>
- 54- Motaghed, S., ghobadi, M., mirzaie Aliabadi, M., & Gharayebi, Y. (2019). Study of the fresh and hardened properties of fiber self-compacting concrete. *Journal of Structural and Construction Engineering*, 6(Special Issue 4), 43-61. <https://doi.org/10.22065/jsce.2018.102143.1366>
- 55- Moradi Tayebi F, Motaghed S, Dastanian R. Evaluation Chaotic Behavior and Time Series Prediction of Tehran Earthquakes. *MCEJ* 2020; 20 (3) :147-160 <http://mcej.modares.ac.ir/article-16-15687-fa.html>
- 56- Nicknam A., Khanzadi M., Motaghed S., Yazdani A. (2017) Applying b-value statistical variation to seismic hazard analysis, *Indian Journal of Geo-Marine Sciences*: 46; 391-396. <https://www.researchgate.net/publication/286600025>
- 57- Motaghed, S., halavat, M. R., & salehi vaysi, M. (1970). Investigation the effect of steel fibers and coarse aggregate ratio on self-compacting concrete properties. *Concrete Research*, 11(4), 95-107. <https://doi.org/10.22124/jcr.2018.10099.1283>
- 58- Poursoltani, R., Pourkermani, M., Yazdjerdi, K., & Almassian, M. (2016). Investigating the Impress of the Active Tectonics and the Rate of Fractures in Ilam Formation, Fars Area, SW Iran. *Open Journal of Geology*, 6(06), 498. <https://doi.org/10.4236/ojg.2016.66041>
- 59- Motaghed, S., yazdani, A., nicknam, A., & khanzadi, M. (2018). Sobol sensitivity generalization for engineering and science applications. *Journal of Modeling in Engineering*, 16(54), 217-226. <https://doi.org/10.22075/jme.2017.12259.1221>
- 60- Yazdani, A., Motaghed, S., & Mehrabi Moghadam, A. (2016). Evaluation of Seismic Risk Effect on Total Reliability Index of Structures, Case Study of Concrete Flexible Frame Frames. *Asas Journal*, 18(43), 26-



[https://www.isceiran.org/article\\_66415](https://www.isceiran.org/article_66415)

61- Khanzadi, M., Motaghed, S., & Asadian Ardakani, A. (2017). A Narrow Band Method for Self Consolidation Concrete Mix Ratios Determination Based on Multi-Criteria Optimization. *Concrete Research*, 9(2), 17- [https://jcr.guilan.ac.ir/article\\_2057](https://jcr.guilan.ac.ir/article_2057)

62- ali roozitalab, Asghari Pari, S. A., Asghari Pari, S. A., Motaghed S., Numerical modeling of the Seismic Response of Shallow Circular Tunnels in Homogenous Layered Ground Using FEM Code ABAQUS and Compare the Results with the Analytical Solutions, *TUNNELING & UNDERGROUND SPACE ENGINEERING*, Volume:6 | Issue:1, p. 17-26, 2017, [https:// doi: 10.22044/tuse.2017.4653.1276](https://doi.org/10.22044/tuse.2017.4653.1276)

63- Motaghed S., khooshecharkh A., 2011, Damage–Based Optimal Longitudinal Reinforcement for RC frames, *European Journal of Scientific Research*, Vol.50, Issue 2, P.191-201. <https://sciexplore.ir/Documents/Details/785-479-041-769>

64- Motaghed S. ,khooshecharkh A., 2011, Probabilistic Evaluation of the Effects of Concrete Compression Strength on the Reinforced Concrete Building Damageability , *European Journal of Scientific Research*, Vol. 50 Issue 2, p.202-207. <https://www.researchgate.net/publication/376831089>

65- Shahidzadeh M.S. , Amani A. and Motaghed S. , 2011, FRP-Steel Relation in Circular Columns to Make an Equal Confinement, *Journal of Applied Sciences*, Vol.11, Issue 5, p. 778 - 787 , [10.3923/jas.2011.778.787](https://doi.org/10.3923/jas.2011.778.787)

66- Normohammadi, A. , Rahimi, H. and Maleki, B. (2021). Pprobabilistic seismic hazard assessment in south-west gas fields in Iran. , 7(2), 217-226. doi: [10.22044/jrag.2021.10056.1299](https://doi.org/10.22044/jrag.2021.10056.1299)

67- Motaghed S., Shahidzade M.S.,2011, Seismic Evaluation of Middle Span Steel I-Girder Bridges, *Journal of Applied Sciences* Vol. 11, Issue 1, p. 104-110, [10.3923/jas.2011.104.110](https://doi.org/10.3923/jas.2011.104.110)

68- Motaghed, S., nakhlian, A., khazaei, M., Dynamic evaluation of steel bridges performance, 6th International Conference on Civil, Structural and Earthquake Engineering, 2021-10-20, Tehran, Iran. <https://www.researchgate.net/publication/377330363>

69- Eftekhari, N., Motaghed, S., Samare, F., Sayyadpour, H., Dependency Analysis of the Seismic Response of Highway Bridges to the Maximum Amplitude of Ground Motion, 6th International Reliability and Safety Engineering Conference, 17-18 Feb, 2021, School of Mechanical Engineering, Shiraz University, Shiraz, Iran. <https://www.researchgate.net/publication/389689326>