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The Terrestrial Road Network Subject to Faulting Systems In Central Iran

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ABSTRACT

The central plateau of Iran constitutes one of the greatest cultural centers of prehistoric Iran. This region is famous for its specific geographical position where its ancient roads connected Mesopotamia and south western roads of Iran to the north eastern roads that iran across Afghanistan, Pakistan, India, and China, and played a vital role in establishing the Silky road. Portions of this connection are still available. This plateau is located on the central folded Alp-Himalian belt, a highly tectonic region on the globe, famous for its active tectonic behavior and fault formation ability which is considered as its main geomorphologic features. The Land-sat satellite images, airborne magnetic maps, GIS and filed investigations indicate that the ancient routs, the King Road and Shahdad Road were constructed in compliance with the tectonic structure and faulting orders of the natural pathway. In statistical analysis the R-squared (adaptation coefficient) of the portions of the rout close to faults indicate a 0.92 in the south-west of the central Iran and a 0.82 in the south-east of the same region.
KEYWORDS: terrestrial roads network, faults, the King road, Shahdad.

1. INTRODUCTION

The inter-social connections constitute the most vital factor in cultural development in human society. The means to accomplish this natural phenomenon in the ancient days was the rout that developed into roads where the design of both was subject to the natural setups, i.e. the land topography. Man had to pass all the natural, obstacles to get from one point to other by observing the superficial geometrical and formed natural patterns as the guidelines. This hardship was reduced when the technology conquered many of the natural obstacles which made it hard to travel across. With all these advances in this modern era the road layout still is the subject of the nature's order, that are earth's main lineaments created by the faults and fractures. The topographical features, especially in tectonically active regions, like the study region, here and the formation of faults and fractured land crust shape up the natural structure according to which the pathways for human have been and are being designed.

The attempt is made in this study to determine the adaptation coefficient and the correlation among the direction orientation of the routs as manmade constructions along or in parallel to the main fault lines of the designated region in the ancient and contemporary periods.

The relevant questions are: To what extent could this adaptation be accepted or rejected? And To what extent do the existing modern roads on the designated region correspond to the main faults' setup?

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The contemplative point here is that Mesopotamia was a civilization center located between two grates Tigris and Euphrates rivers while the central Iran served the same purpose by becoming a civilization center as well as a transit point in connecting routs among civilizations (Majidzadeh, 1990).

Two vital factors have been involved in developing residential areas in a given area: the potential of the region for living and the geographical position which allowed the shortest and easiest way to connect to other cultural centers. Most of all ancient residential places were located along the main roads of today in the central plateau of Iran. Hence it can be assumed that these ancient residents have been using such roads (Majidzadeh, 1989).

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Now, if the road networks were adapted to the fault systems and the same roads lead to promotion of living conditions of residential areas it could be deduced that the fault systems have had their indirect contribution in social development.

LITERATURE REVIEW

For human civilization the first and the most important rout has been the Dead Sea fault line which could be considered as the migration pathway of human from point of origin that is Africa to other points on the planet earth (Zvi Ben et.al, 2005). Adaptation of these ancient pathways to faulting lines is a result of the faults' dynamical features leading to destruction of commercial roads in ancient Greece during the earthquakes of 1200 A.D and substituting to new pathways in turn that led to cultural evolvement (force, 2010).

The archeological evidences on the paths along the main fault line in the subject plateau indicate the existence of both the human-nature phenomena (Hasanalian, 2001). Babajamali had conducted studies on the fault lineament influence on civilization formation in local scale. According to him in Zagros region, the fault lines have caused many fault springs that facilitate the migrants' paths by providing theme water and organizing their travel manners (Babajamali, 2007).

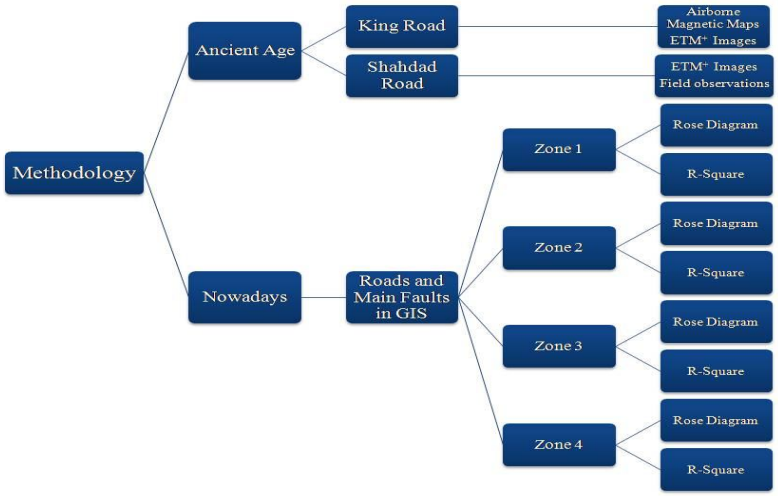
MEHODOLOGY

The plateau under study covers a 625000 km^2 area. This study is conducted in two sections.

Section one: In order to analyze the manner of the ancient roads with the fault lines the two main roads of the ancient times, the King and Shadad roads are analyzed. Here the ETM Landsat and airborne magnetic maps in addition to field visits and studies are involved in analyzing the Kings road but for analyzing the Shadad road all but airborne magnetic maps are applied.

Section two: In order to determine the correlation between today's roads and the terrestrial roads with respect to fault lines in the region the International Institution of Earthquake and Seismology (IIEES) maps are used for digital layer production which revealed three types of roads in terms of priority and importance.

The study region is divided in four zones. For each zone two approaches are made in order to produce Rose diagram and R-square.



DISCUSSION

The King road is an east-west road constructed in Achaemenian Period. One of its important sections named, Bolaghi Valley, connects Pasargad (Achaemenian capital city) to Persepolis (Achaemenuans's pringresort Palace). This path is on the Bolaghi mountain pass along Sivand River and perpendicular to an anticline. In this study, ETM^+L and sat images and airborne magnetic maps are used to identify fault structures. During the study a new earth rupture was noticed in the mountain pass (see Figures 1).

Archeological investigations indicate that the city of Shahdad has been inhabited since late 5^{th} century B.C (Kaboli,1987). This city is located at central Iran plateau on the Loot desert margin and was one of the important commercial centers in the region; hence the roads' contribution to this city has been substantial. The city was in proximity of regions like Tape Yahya and Tape shaytan in Kerman province (Majidzadeh, 1987). To pass through

this region, the Shahdad- Sirch- Golbaft paths must be traveled. This pathway known as Gook's fault is one of the seismically active ones. Slip- rate of Gook fault (Golbaft) is reported about 3.8-3.7mm per year (Waker.et.al, 2010). During the last 30 years, this fault has generated at least five big earthquakes (Barbarian, 2001). Bam earthquake in 2003is attributed to this fault (Talebial et al, 2003). Images from Landsat satellite show the location, position of Golbaft faults, the Shahdad road and two rural areas along this road on fault line (Figure 2).

In the second section of methodology, the digital layers of the active faults of the study area are adapted to the same roads in a GIS environment (Fig 3). Since there exists a different general trend in land topography the faults of the region is divided in four zones. Here for each zone the all the faults with corresponding grade one roads are drawn on Rose Diagram. The findings are as follows:

- In zone 1, north east of central Iran plateau (Fig 4)

Faults directions are mostly westwards, south westwards and a portion are north-westwards while most of the roads here are in east-west direction.

- In zone 2, southeastern part of central Iran plateau (Fig 5)

Faults orientation is north-northwest, but the roads orientation is mostly northwards.

- In zone 3, southwestern regions of central Iran plateau (Fig 6)

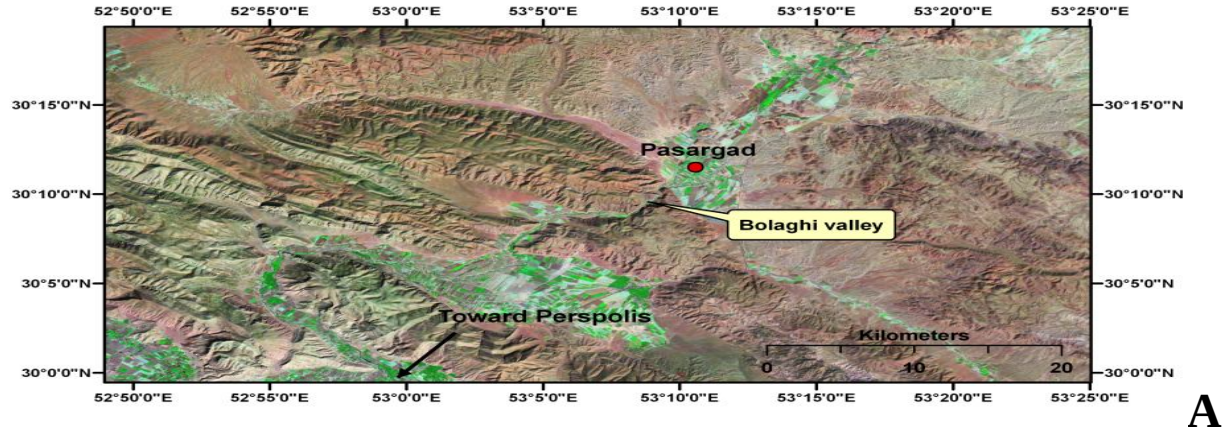
Faults mainly have northwest orientation while roads are directed northwest and a major section has a northeast orientation.

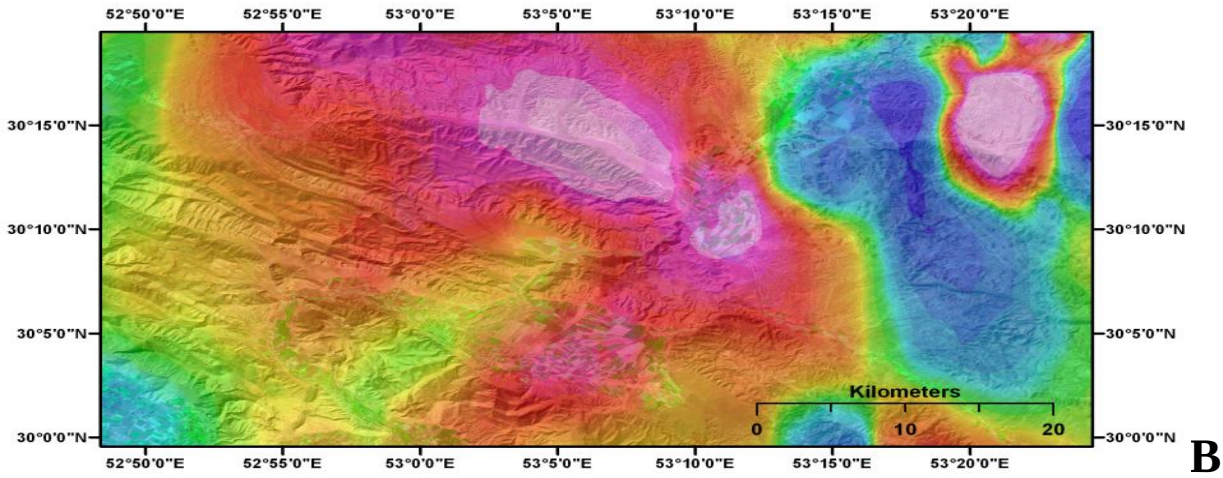
- In zone 4, Northwestern part of central Iran plateau (Fig 7)

The faults'orientations is eastern and Western while the roads' orientations are south and north.

The attempt is made to find the correlation coefficient where the roads are in proximity of the faults (less than 10 Km). The result indicates that in zone four (southwest) the highest correlation coefficient is 0.93, in northwest is 0.92, in northeast is 0.9 and in southwest is 0.82 (Fig 8).

A few images from Google Earth are presented regarding the adaptation of natural and manmade structures. (Fig 9)






C


D


E


F

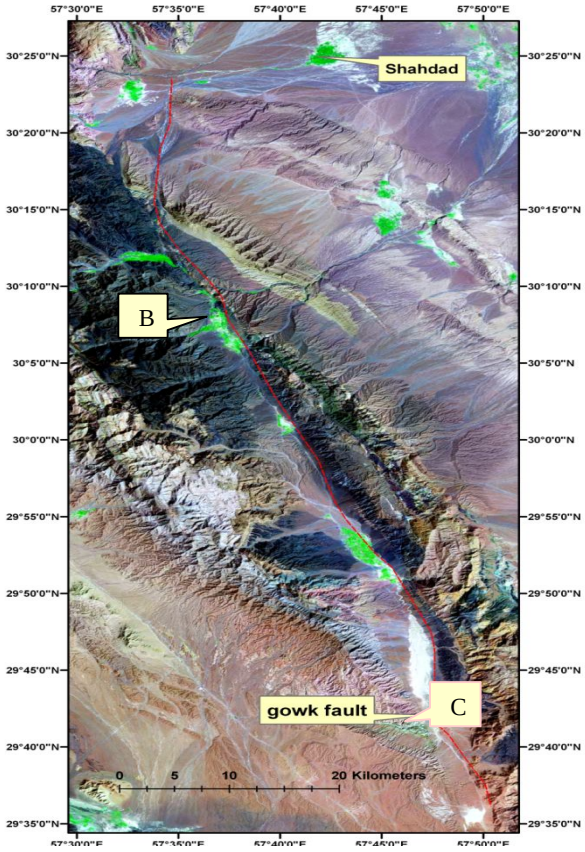
Figure 1: Pictures of Bolaghi Valley (King Road)

A: ETM^{+}landsat image from Pasargad and Bolaghi Valley;

B: A part of airborne magnetic maps (X axis) taken from Eghlid maps 1/250000 scale (image A is in the background).An apparent rapture is observed right on the path in Bolaghivally.

C: Oblique photograph from Bolaghi Valley (taken from North East). Pasargad is located at the left end of the photo;Sivandriver and a part of King Road are seen in the picture

D, E, and F: Some parts of King Road in the Bolaghi Valley



A

B

C

Figure 2: A: ETM^{+}landsat image from Shahdad to Golbaft and Gok fault
B: Fandoghagh village in the path of Shahdad to Golbaft which is on the fault and near the road
C: Davazdah-Emam-e-Hashtadan village in the path of Shahdad to Golbaft which is on the fault and near the road

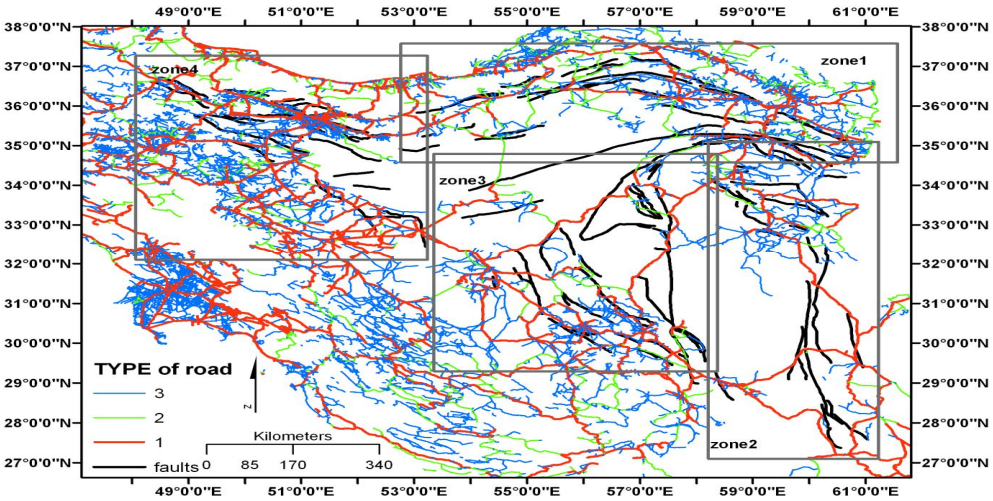
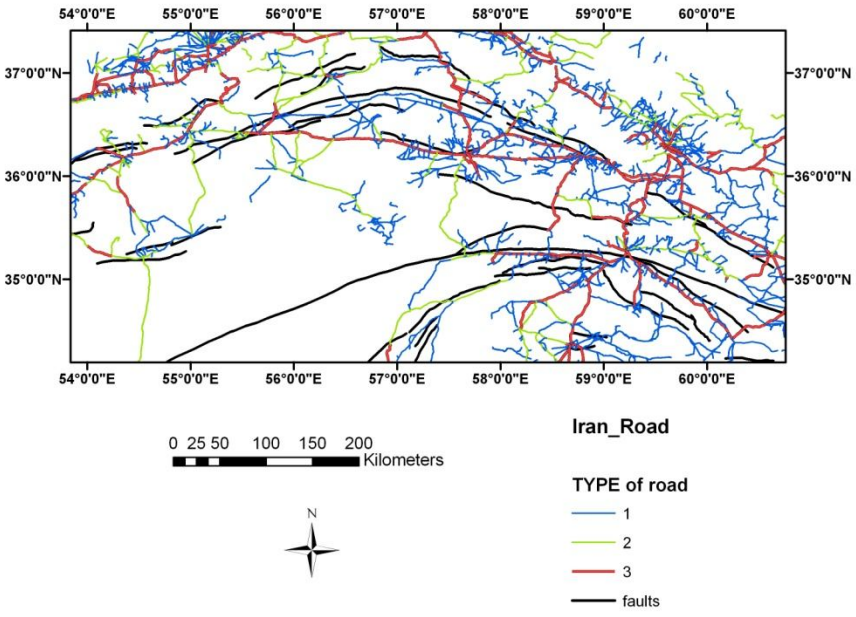


Figure 3:The central Iran roads map along with main faults



A

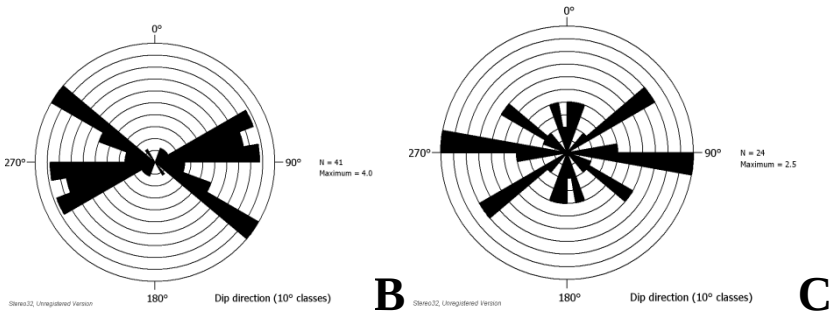
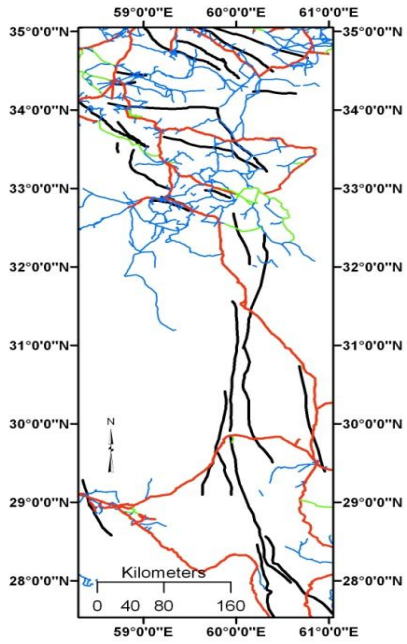


Figure 4: A: Map of Zone 1. Conformity of main faults with road
B: Rose diagram of main faults in Zone 1
C: Rose diagram of roads in Zone 1



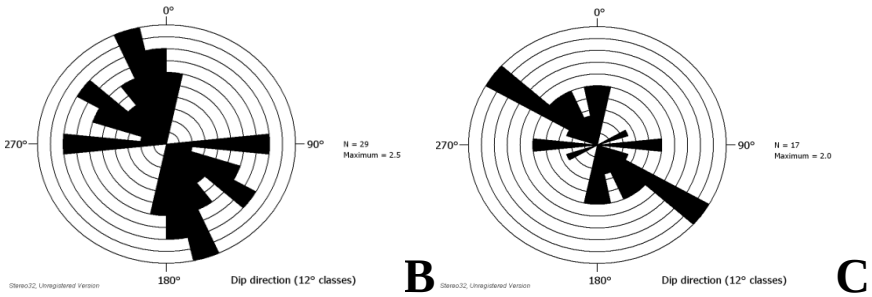


Figure 5: A: Map of Zone 2. Conformity of the main faults with road
B: Rose diagram of main faults in Zone 2
C: Rose diagram of roads in Zone 2

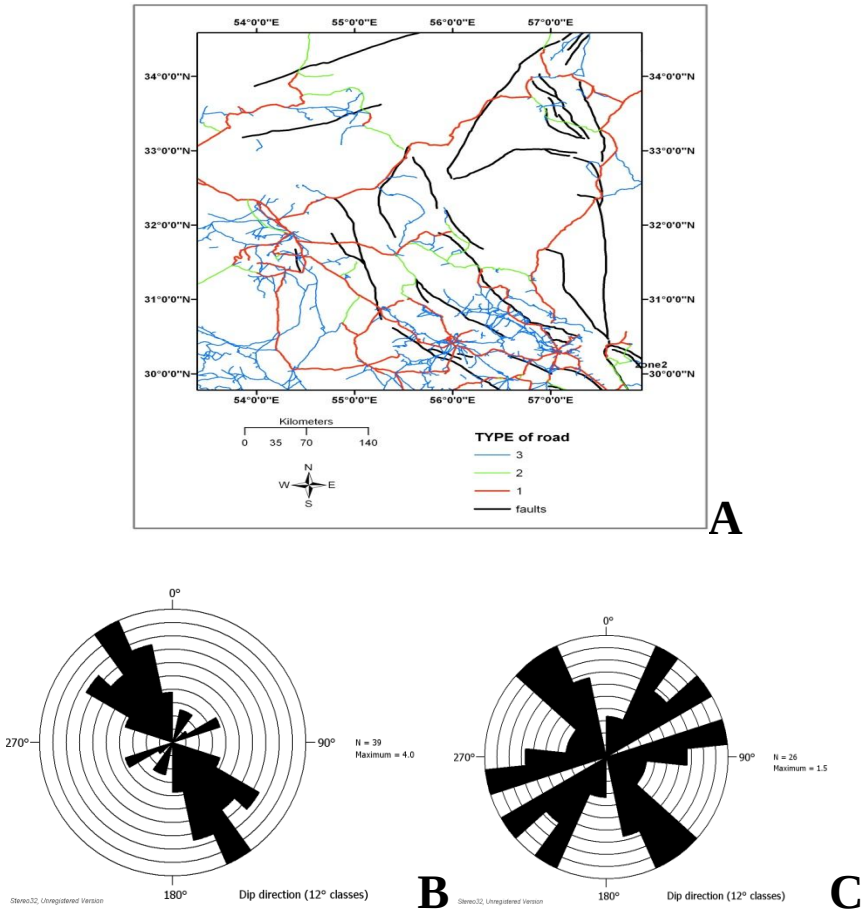
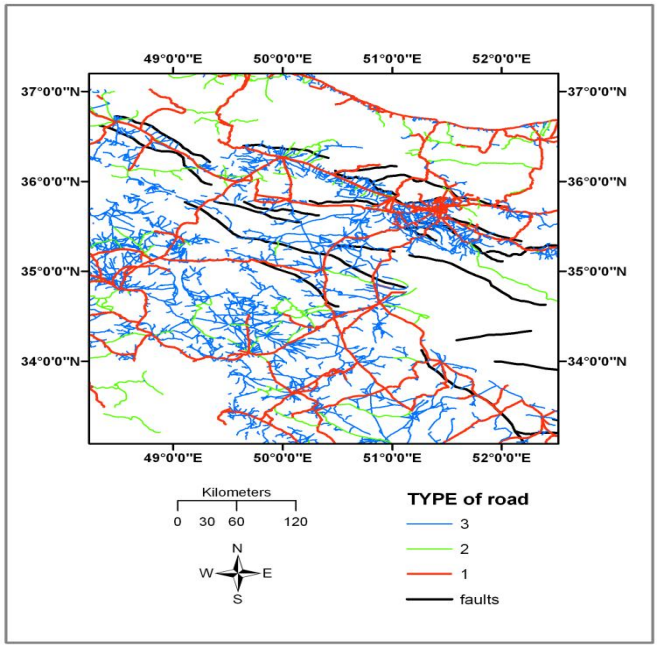


Figure 6: A: Map of Zone 3. Conformity of the main faults with road
B: Rose diagram of main faults in Zone 3
C: Rose diagram of roads in Zone 3



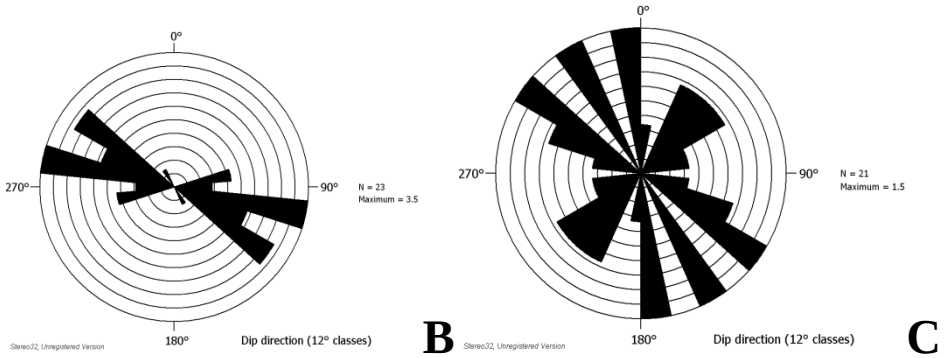


Figure 7: A: Map of Zone 4. Conformity of the main faults with road
B: Rose diagram of main faults in Zone 4
C: Rose diagram of roads in Zone 4

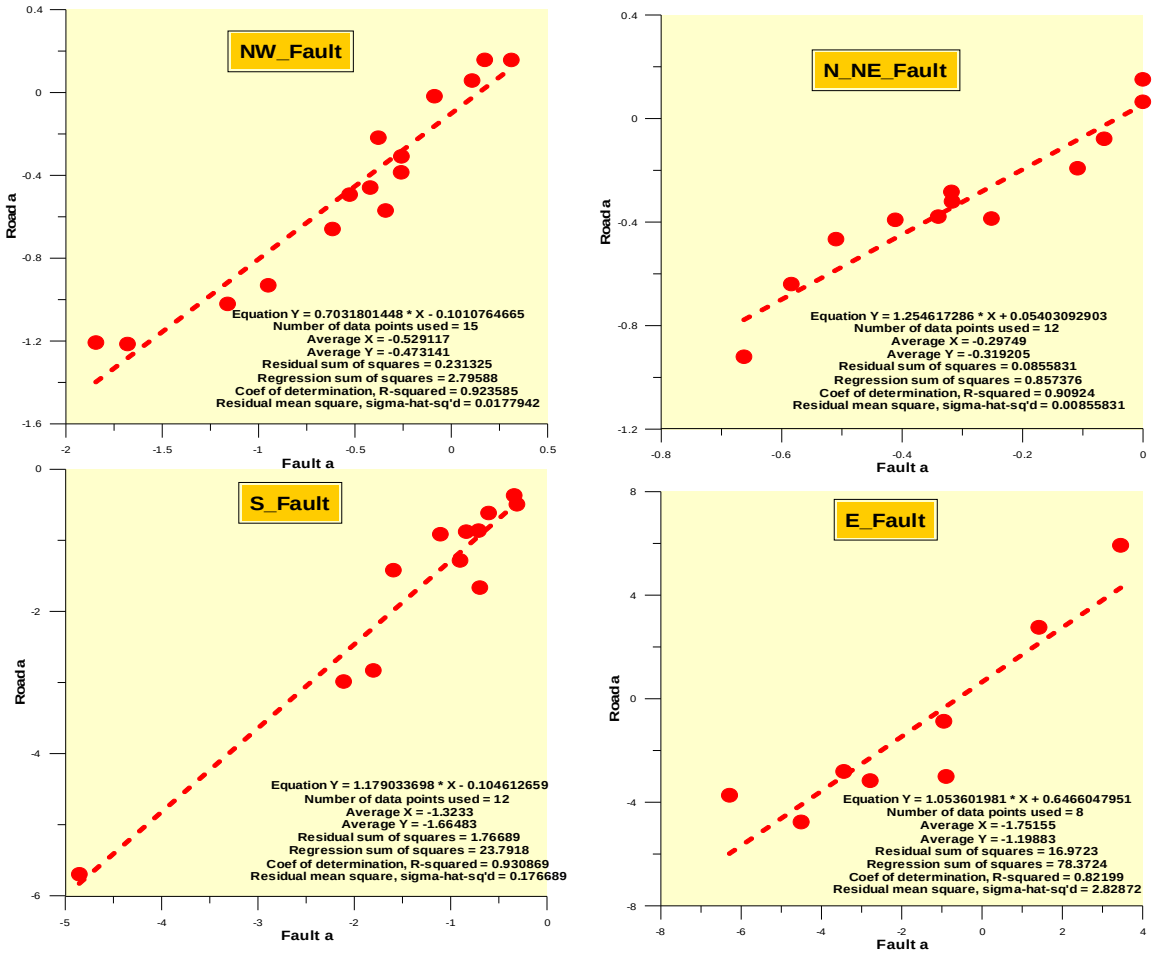
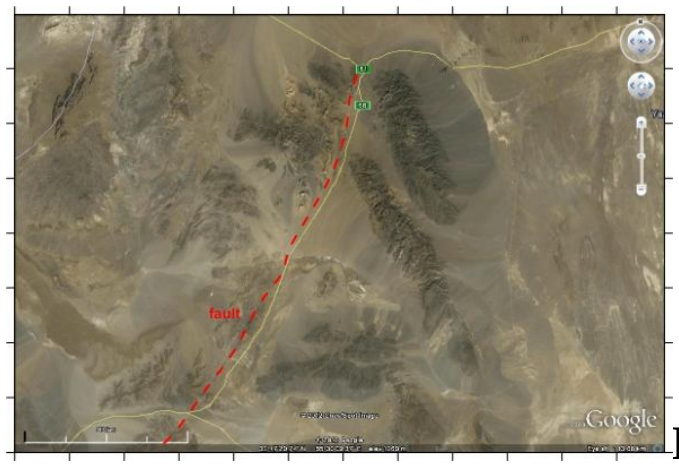


Figure 8: Graphs which show correlation coefficient between alongside of roads and faults for areas in which roads and faults meet each other.
Left, top Zone 1
Right, top: Zone 2
Right, bottom Zone 3
Left, bottom Zone 4
At the bottom of each graph, there is the correlation function and its R-square. The maximum R-square is 0.93 for Zone 4 and the minimum R-square is to 0.82 for Zone 3.

A



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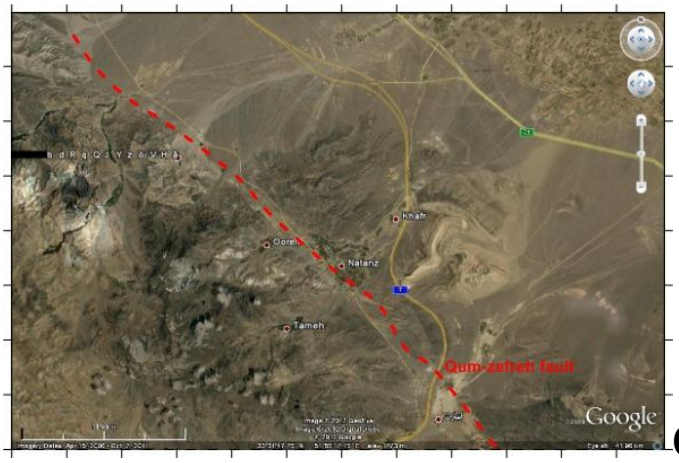

C

Figure 9: A: Google map of Kashmar-Bardaskan road along Darooneh fault
B: Google map,Tabas road along great Kavir fault
C: Google map,Natanz-Kashan along Qom-Zefreh fault

Conclusion

The historical and archeological investigations, filed observations and satellite images regarding the Kings Roadand in Shahdad region illustrate a suitable adaptation of roads with faults. The roads of today, stretched along central Iran plateau have considerable correlation with the faulting systems, suggesting that the tectonic and faulting systems had a great contributionin the construction of the terrestrial roads and pathways. Through such studies it becomes evident that the land topographic elements, in this case the faults lines have contributed to road design since time immemorial in this region where a close correlation is found in the adaptability of roads constructed by man with natural factors which have enhanced the socio-economic prosperity of the civilizations that these roads have crossed.

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