Thank you for your comments, first of all I would like to emphasize that like many other published articles there may be also some uncertainty in this case study, but we have used a tenable method to reach a result correspondent to the theory of Coulomb failure.

For the relation between lythostatic pressure and Coulomb stress changes as you know, in the process of determining Coulomb stress, Mohr circles are plotted with lythostatic pressure defined as the first principal stress. The first relation in this process is

$$\sigma_1 = \rho g h \tag{1}$$

and then for the second and third principal stresses

$$, \sigma_3 = \mu \, \sigma_1 \tag{2}$$

$$\text{and } \sigma_2 = 0.88\sigma_1 \tag{3}$$

For the relation between stresses we have

$$R = \frac{\sigma_1 - \sigma_2}{\sigma_1 - \sigma_3} \text{ (See e.g. Terakawa et al., 2010; parry, 2004)} \tag{4}$$

where, ρ, g, h and μ are the density of Earth's crust, the gravitational constant, the depth of the Earthquake and the friction coefficient standard respectively.

Mohr's circles can be plotted by using Eqs. (1), (2), (3) and (4). According to Mohr circles, shear and normal stresses are calculated only at the time of Earthquake.

On the other hand, stress needed for failure of the say, Earth's crust maybe normal (tensile or compressive) or shear stress or a combination of these two stresses, that can be calculated. It can be calculated for a created fracture in the body with the same slope, but for a fault zone of different pieces with different slopes one may not be able to use only shear or normal stresses. Since the shear stress is zero in some Earthquakes. For example, shear stress is zero for 1987 and 2002 Earthquakes (fig. 1). So we cannot worked only with shear stress in a zone of faults, that we are working on.

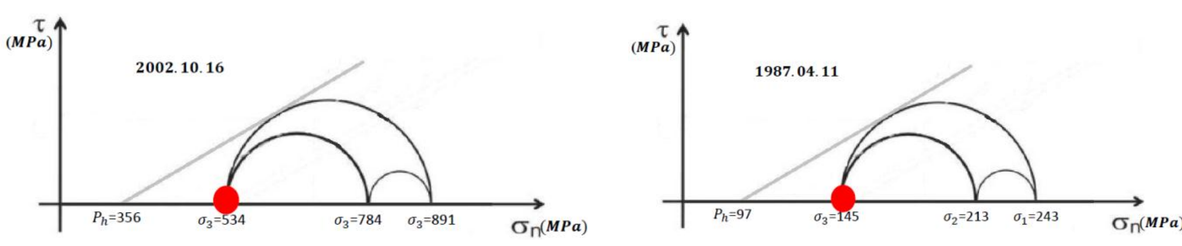


Figure 1. Mohr circles for Earthquakes with zero shear stress.

So we have to work with the merge of the two stresses. As you know Coulomb stress is a merge of two shear and normal stresses.

In the Coulomb criterion, failure occurs on a plane when the Coulomb stress exceeds a specific value, that is defined as

$$CFF = \tau_n + \mu' \times \sigma_n, \text{ (Miao and Shou-Biao, 2012; Harris, 1998)} \tag{5}$$

Where τ_n is the shear stress on the failure plane, σ_n the normal stress, and μ' the effective coefficient of friction.

However, by this definition, the stresses are at the time of failure determined by Mohr circles.

On the other hand, this type of Coulomb stress as the static Coulomb stress change is used to predict the next Earthquake or aftershocks places (e.g. Coco, 2000). Based on the static Coulomb stress changes (e.g. Yao-Lin and Jian-Ling, 2010; King and Coco, 2001), we calculate the Coulomb stress before the Earthquakes.

In fact, we are trying to find a merge of stresses (CFF) for times before Earthquakes using Eq. (5).

Coulomb stress changes from an initial value after previous Earthquake to a final value of the exact time of the next Earthquake, according to Coulomb failure diagram. We use Eq. (5), as the final value of Coulomb stress (fig. 2 - part b - point 1). But we have to find a value for the initial value of the diagram (point 2).

According to the Coulomb failure graph we know this is not usually zero, on the other hand, there is a drop in initial stress after any Earthquake with compared to the previous one (fig. 2a).

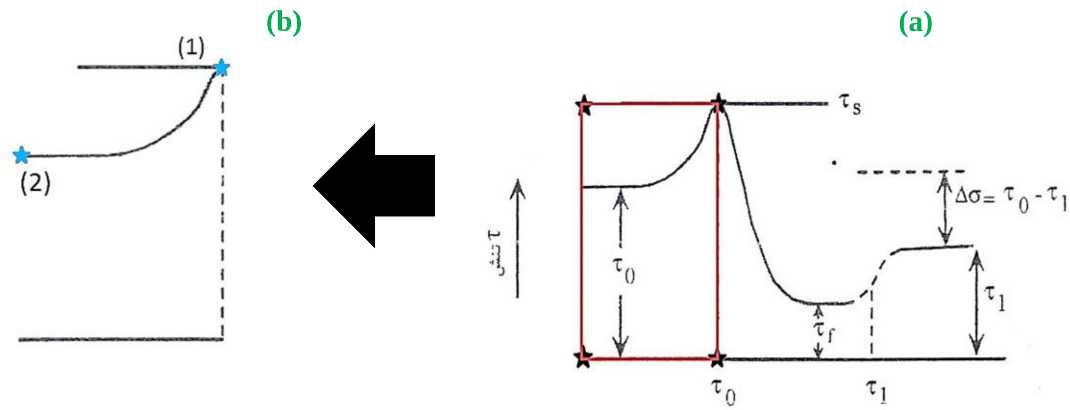


Figure 2. Theoretical Coulomb failure diagram and special diagram to calculate the stress (Zare, 2005).

These stress drops are calculated in article by Eqs (6) and (7).

$$\Delta\sigma = \frac{2}{\pi}\mu\left(\frac{\bar{D}}{w}\right) \qquad (6)$$

$$\Delta\sigma = \frac{4(\mu+\lambda)}{\pi(2\mu+\lambda)}\mu\left(\frac{\bar{D}}{w}\right) . \qquad (7)$$

These are very negligible as is explained for Earthquakes with different surface displacements. So, the initial stress of an Earthquake is almost the same as the initial value of the next Earthquake.

You know, the gray line in the Mohr circles (fig. 3) is the failure line indicates the probability of rupture. This means, the plane of the Earth's crust may be broken at any normal stresses after this line (in positive direction of normal stress axis) (Parry, 2004). For example, points (1), (2) and (3) are not in failure position, but for points (4) and (5) there are probability of failure, although point (1), (2) and (3) have more shear or normal stresses than other points. For this type of stress structure, minimum stress for the possibility of failure is points (6) on the line of failure.

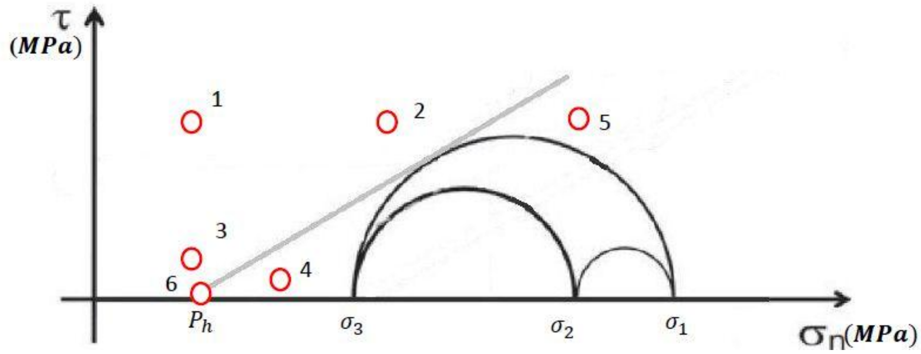


Figure 3. The possibility of failure of according to the position of shear and normal stresses in Mohr circles.

Point (6) is the fluid pressure (e.g. Terakawa, 2010), that is one of the main (normal) stress in Mohr circles. As a result, this point is written by using Eq. (5) as

$$CFF_i = \mu' \times P_h \ . \qquad (8)$$

Because of these, we defined the Coulomb stress (Eq. (8)) as the initial Coulomb stress value.

On the other hand, since the total failure is purposed (fig. 4) and the stress on the whole plane is considered, we put minimum initial Coulomb stress that is 30.4 MPa.

Of course, for some Earthquakes the initial Coulomb stress value is greater than this, e.g. that of 1911. The related piece of fault of this Earthquake is shown in fig. 4 – line (1). Other Earthquakes of this piece are shown with stars in Table 1. According to Mohr circles the initial Coulomb stress of Earthquake of this piece is 38.88 MPa. But in this study the whole fault is under study (fig. 4 - line 2), so the minimum initial value is considered to be 30.4 MPa.

For the same reason, since Coulomb rupture diagram (fig. 2 – part b) is considered for the entire fault, it is reasonable that the time difference between events to be considered as the average time of events. Certainly, This time is more for Earthquakes of more magnitude and less for Earthquakes of small magnitude along the line (2). In this case we can better express that which pieces of the fault is in greater risk.

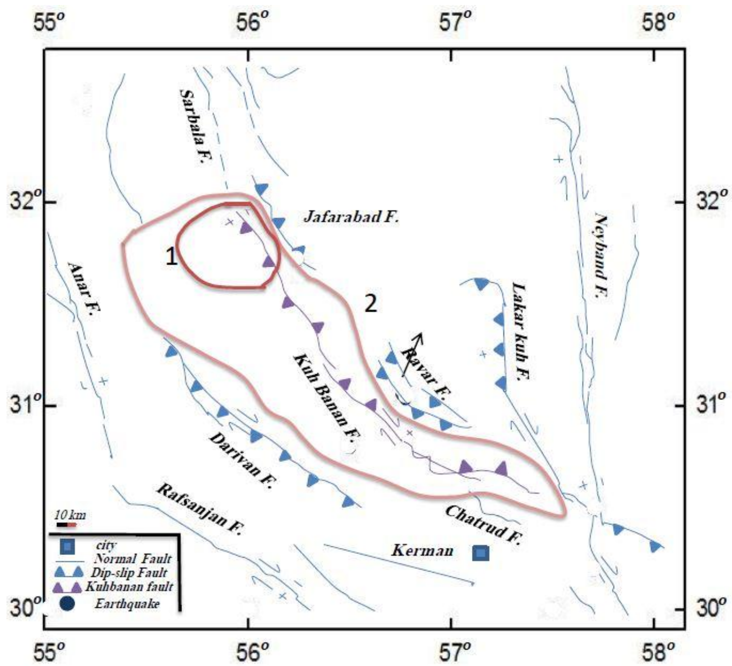


Figure 4. The whole fracture under this study is displayed in line (2), Line (1) shows one piece of this fault.

In this study, we are trying to consider the whole failure and calculate stresses that have caused the failure. For your comment on the number of Earthquake before 1977, this is because of the range of Earthquake's magnitude, we changed it to Earthquakes of magnitude of 4.8 and more. We have found 19 events in the area (fig. 5) from 1900 to 2014 with magnitude 4.8 or more.

	Date	magnitude	Focal depth (km)	Dip (degree)	Source
1	1911/04/11*	6.7(MS)	31.9899	56	[1,2],ISC, CMT
2	1913/03/24	5(mb)	31.05	56.77	[6]
3	1929/05/17	5.2(mb)	30.86	56.52	[2], ISC
4	1933/11/28*	6.2(MS)	31.9899	56	[1], CMT
5	1934/01/01	5.3(mb)	30	57.5	ISC
6	1937/02/13	5.3(mb)	30.84	56.55	[2], ISC
7	1946/09/19	5.1(mb)	31.65	56.18	[4,6]
8	1951/10/08	5.2(mb)	31.38	56.24	[2], ISC
9	1953/01/15	5.1(mb)	31.06	56.76	[4,6]
10	1959/01/07	5.1(mb)	30.85	56.60	[2], ISC
11	1959/12/08	5.1(mb)	31.05	56.77	[4,6]
12	1960/07/25	5(mb)	30	56	ISC
13	1961/05/21	5(mb)	31.06	56.76	[4,6]
14	1962/11/06	5.5(mb)	30	55	ISC
15	1969/09/02	5.3(mb)	30.2	57.7	ISC
16	1972/11/10	5.1(mb)	30.5	57.7	ISC
17	1974/11/17	5.2(mb)	32.5	55.2	ISC
18	1977/09/17	4.8(mb)	30.88	56.54	[2], ISC
19	1977/11/10	4.8(mb)	30.91	56.50	[2], ISC
20	1977/12/19	5.3(mb)	30.9068	56.48	[3]
21	1978/05/22*	5(mb)	31.8186	56.085	[4], ISC
22	1981/06/27	5(mb)	31.2746	57.385	ISC

23	1984/08/06	5.6(mb)	30.8413	57.17	[3]
24	1987/04/11*	5(mb)	31.6423	56.115	[4], ISC
25	2002/04/05*	5(mb)	31.9899	56	[2], CMT
26	2002/10/16	5(mB)	31.3904	56.43	[4], ISC
27	2004/10/14	5.1(ML)	31.7229	56.995	ISC
28	2005/02/22	6.4(MS)	30.7809	56.775	[5]
29	2006/05/07	5(mb)	30.7809	56.645	CMT, ISC
30	2007/02/19	5.1(mb)	30.8766	56.82	[5]
31	2009/02/15	5(mb)	31.0277	57.095	ISC
32	2012/02/27	5.2(mb)	31.410	57.76	ISC
33	2012/12/03	5(MN)	30.539	57.225	ISC
34	2013/01/21	5.4(mb)	30.2317	57.445	ISC

Table 1. List of Earthquakes in the region from 1900 to 2014, references (ISC: International Seismological Centre; CMT: Global CMT Catalog Search; [1]: Berberian, 1976; [2]: Berberian, map, 1976; [3]: Baker, 1993; [4]: Berbriyan et al., 1984; [5]: Talebiyan et al., 2006; [6]:Melville and Ambraseys, 1982).

Since only Kuhbanan fault (fig. 4 - line 2) is important for us, there are only eight Earthquakes of 4.8 and more on this in the mentioned period of time (1900 –1977) (Table 2).

	Date	magnitude	Focal depth (**km**)	Dip (degree)	Source
1	1911/04/11	6.7(MS)	30	72	[1,2], ISC, CMT,here
2	1929/05/17	5.2(mb)	20	87	[2], ISC
3	1933/11/28	6.2(MS)	27	72	[1], CMT,here
4	1937/02/13	5.3(mb)	17	84	[2], ISC
5	1951/10/08	5.2(mb)	15	90	[2], ISC
6	1959/01/07	5.1(mb)	15	82	[2], ISC
7	1977/09/17	4.8(mb)	33	90	[2], ISC
8	1977/11/10	4.8(mb)	33	90	[2], ISC
9	1977/12/19	5.3(mb)	7	82	[3]
10	1978/05/22	5(mb)	32	72	[4], ISC,here
11	1984/08/06	5.6(mb)	11	35	[3]
12	1987/04/11	5(mb)	9	90	[4], ISC,here
13	2002/04/05	5(mb)	33	72	[2], CMT,here
14	2002/10/16	5(mB)	33	90	[4], ISC,here
15	2005/02/22	6.4(MS)	7	60	[5]
16	2006/05/07	5(mb)	12	73	CMT,ISC
17	2007/02/19	5.1(mB)	13	60	[5],here
18	2012/12/03	5(MN)	13	65	here

Table 2. Earthquakes on the fault Kuhbanan from 1900, references (ISC: International Seismological Centre; CMT: Global CMT Catalog Search; [1]: Berberian, 1976; [2]: Berberian, map, 1976; [3]: Baker, 1993; [4]: Berbriyan et al., 1984; [5]: Talebiyan et al., 2006).

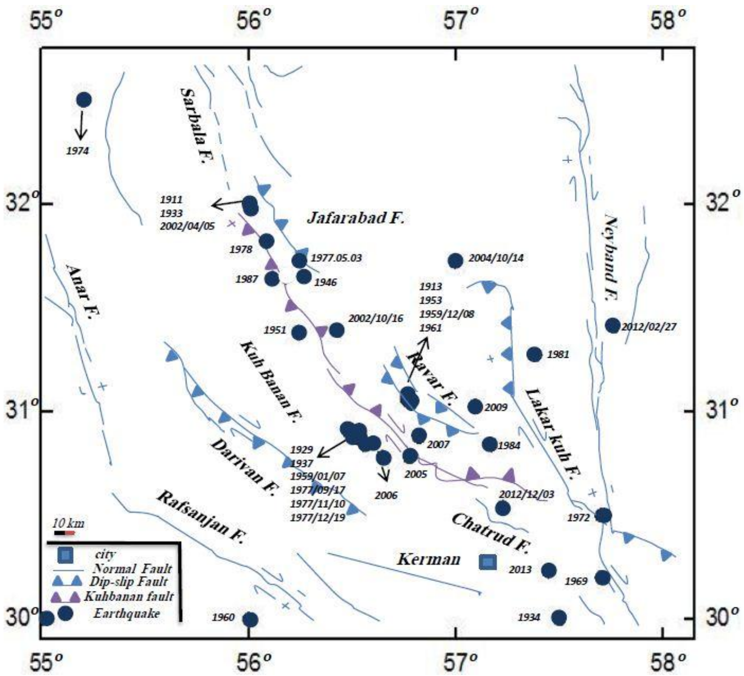


Figure 5. Earthquakes in the range of fig. 1 in article from 1900.

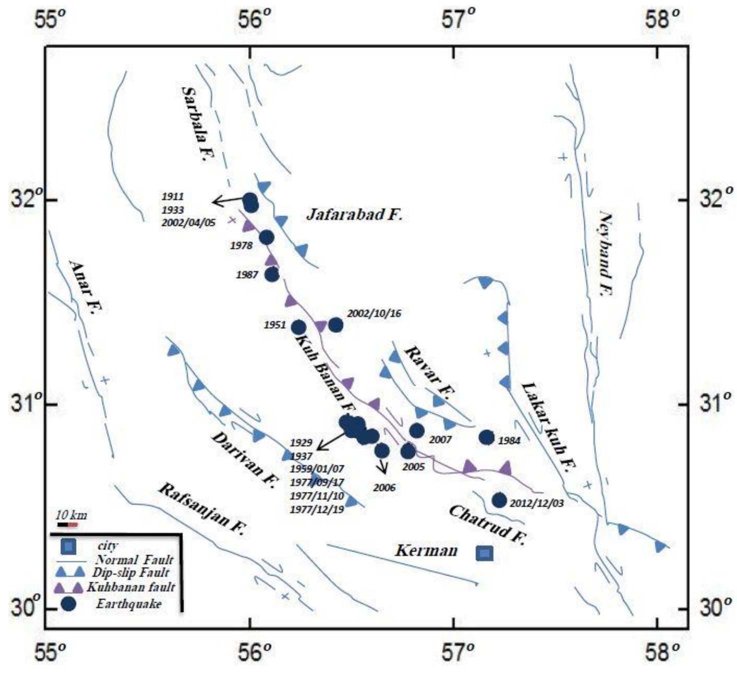


Figure 6. Considered Earthquakes in Table 2.

100

Once again, the first, second and third principal stresses, fluid pressure the shear and normal stresses, finally the initial and final Coulomb stress were calculated for each Earthquake in Table 2 as shown in Table 3.

	Date	The principal stress (σ_1) (MPa)	The principal stress (σ_2) (MPa)	The principal stress (σ_3) (MPa)	Fluid pressure (P_h) (MPa)	Shear stress (τ_n)	Normal stress (σ_n)	Initial Coulomb stress (CFF_i) (MPa)	Final Coulomb stress (CFF_f) (MPa)
1	1911/04/11	810	712.8	486	324	95.17946	516.9089	129.6	301.943
2	1929/05/17	540	475.2	324	216	11.28337	324.591	86.4	141.1198
3	1933/11/28	729	641.52	437.4	291.6	85.66151	465.218	116.64	271.7487
4	1937/02/13	459	403.92	275.4	183.6	19.07676	277.404	73.44	130.0384
5	1951/10/08	405	356.4	243	162	0	243	64.8	97.2
6	1959/01/07	405	356.4	243	162	22.3156	246.1346	64.8	120.7695
7	1977/09/17	891	784.08	534.6	356.4	0	534.6	142.56	213.84
8	1977/11/10	891	784.08	534.6	356.4	0	534.6	142.56	213.84
9	1977/12/19	189	166.32	113.4	75.6	10.41395	114.8628	30.24	56.35908
10	1978/05/22	864	760.32	518.4	345.6	101.5248	551.3695	138.24	322.0726
11	1984/08/06	297	261.36	178.2	118.8	55.83749	217.3383	47.52	142.7728
12	1987/04/11	243	213.84	145.8	97.2	0	145.8	38.88	58.32
13	2002/04/05	891	784.08	534.6	356.4	104.6974	568.5998	142.56	332.1373
14	2002/10/16	891	784.08	534.6	356.4	0	534.6	142.56	213.84
15	2005/02/22	189	166.32	113.4	75.6	32.72572	132.2826	30.24	85.63877
16	2006/05/07	324	285.12	194.4	129.6	36.21954	205.4675	51.84	118.4065
17	2007/02/19	351	308.88	210.6	140.4	60.77634	245.6677	56.16	159.0434
18	2012/12/03	351	308.88	210.6	140.4	53.75635	235.6525	56.16	148.0174

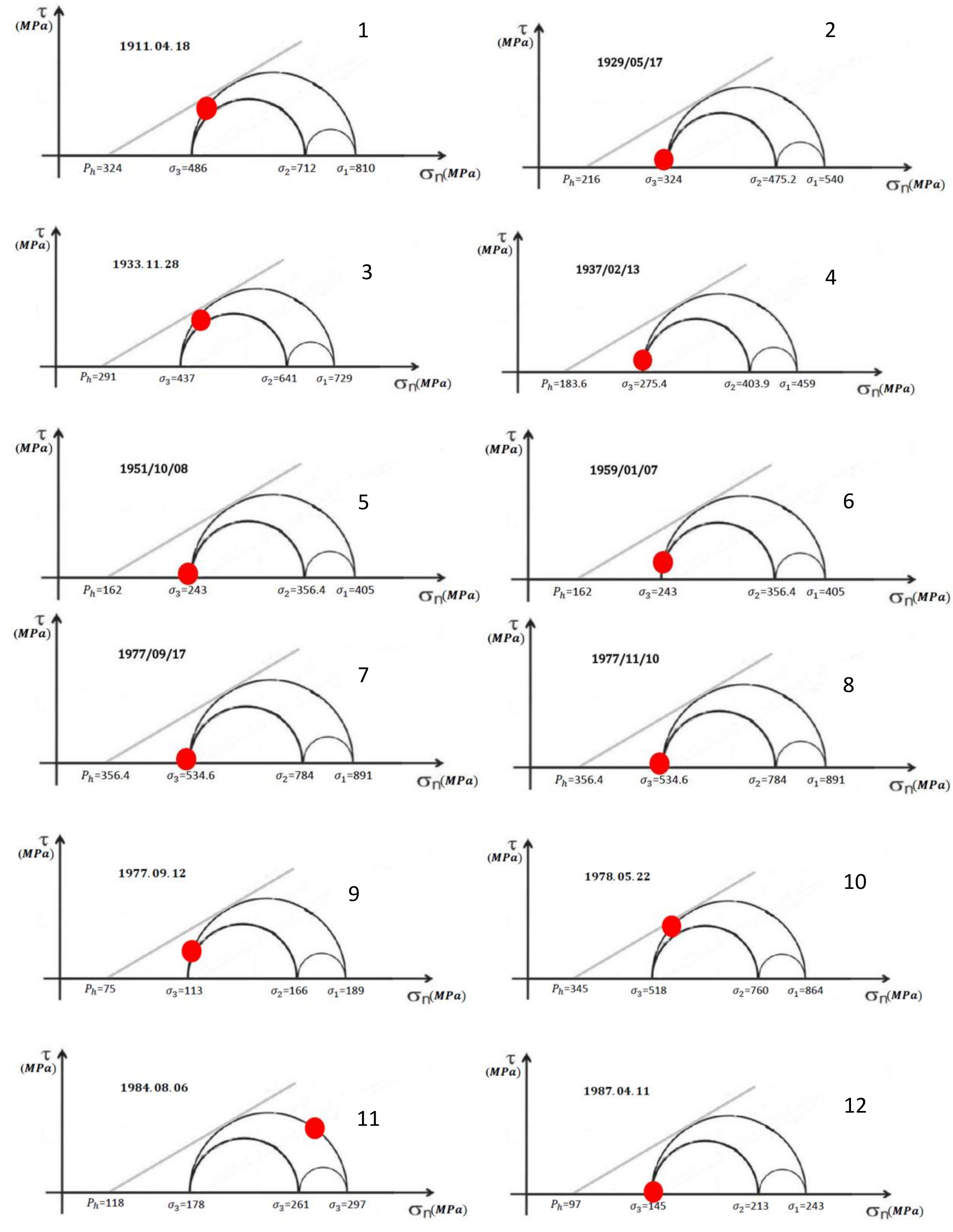
Table 3. calculated stresses for each Earthquake in Table 2.

Also the average failure time can be the average time difference between the events shown in the Table 2 (Table 4)

Years of Earthquake occurrence	Time difference (in terms of year/month/day)
1911 - 1929	18/02/05 - 6610
1929 - 1933	04/07/11 - 1653
1933 – 1937	03/03/18 - 1173
1937 – 1951	14/08/25 - 5326
1951 - 1959	08/04/01 - 3013
1959 - 1977/09/17	18/09/10 - 6827
1977/09/17 - 1977/11/10	0/02/23 - 44
1977/11/10 - 1977/12/19	0/02/08 - 39
1977/12/19 - 1978	0/06/03 - 154
1978 - 1984	06/03/17 - 2267
1984 - 1987	02/09/06 - 980
1987 - 2002.04.05	14/12/27 - 5475
2002.04.05 - 2002.10.1	0/07/13 - 194
2002.10.16 - 2005	02/05/09 - 859
2005 - 2006	01/03/15 - 439
2006 - 2007	0/10/15 - 288
2007 - 2012	05/10/24 – 2123
average time	2203

Table 4. The time difference between occurred Earthquakes with magnitude of 4.8 and more.

Therefore according to Table 2, 3 and 4, figs. 4 and 5 in article are modified to figs. 7 and 8.



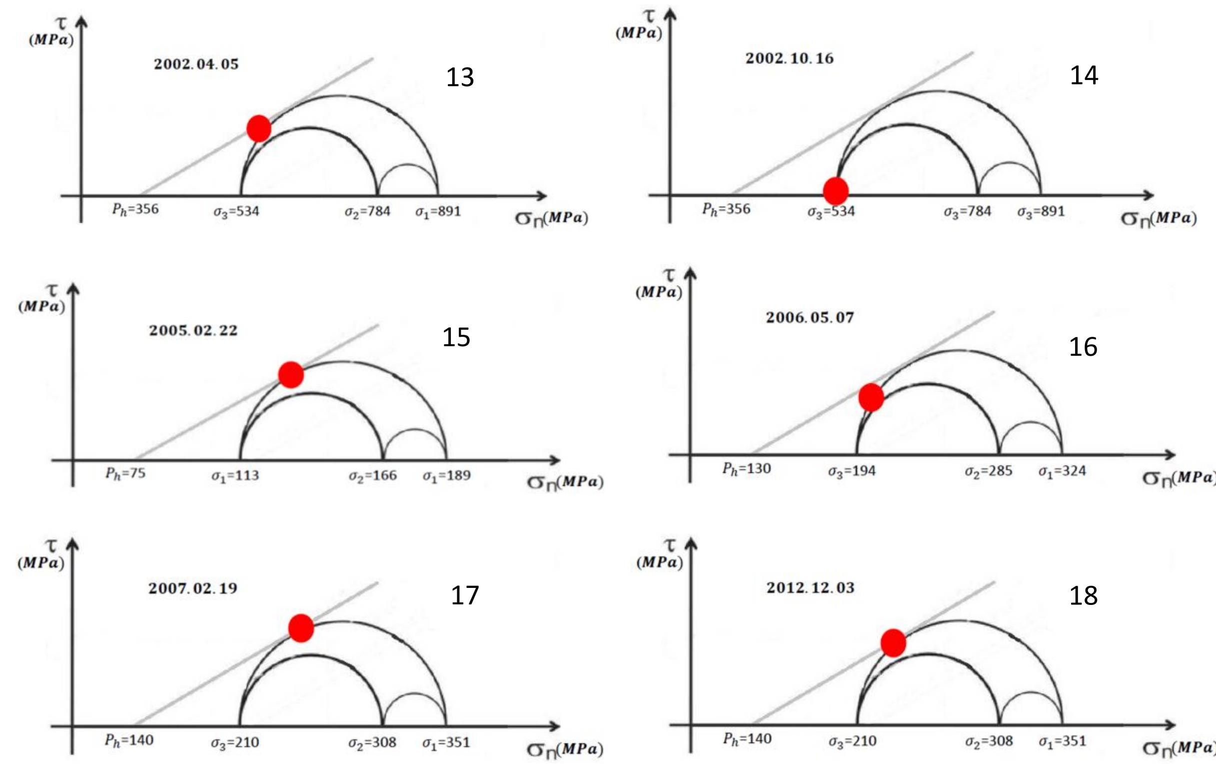
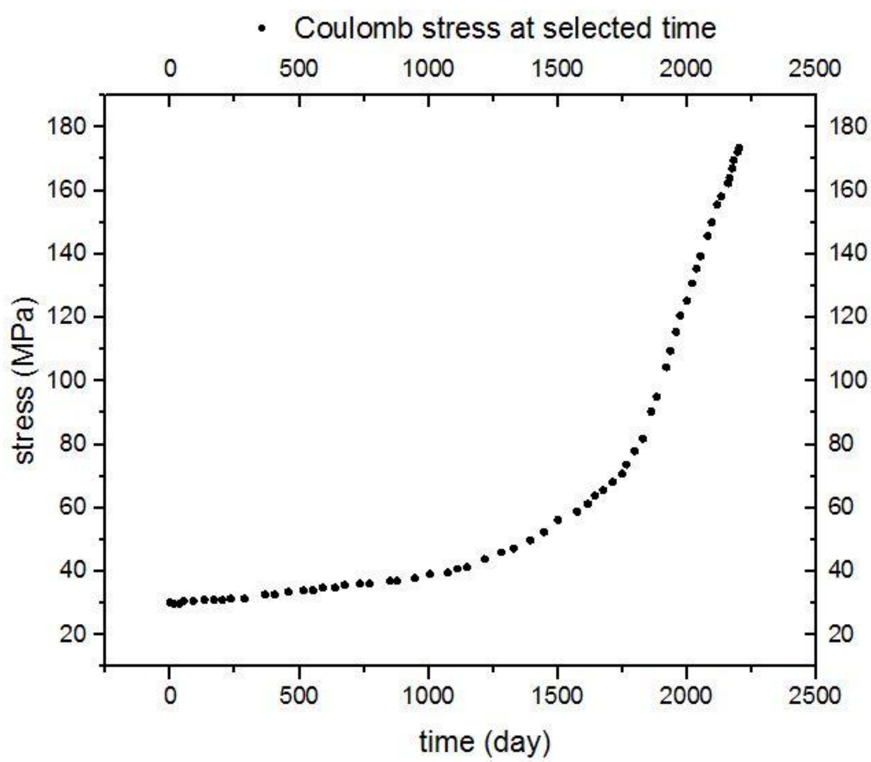


Figure 7. Modified fig. 4 in the article.



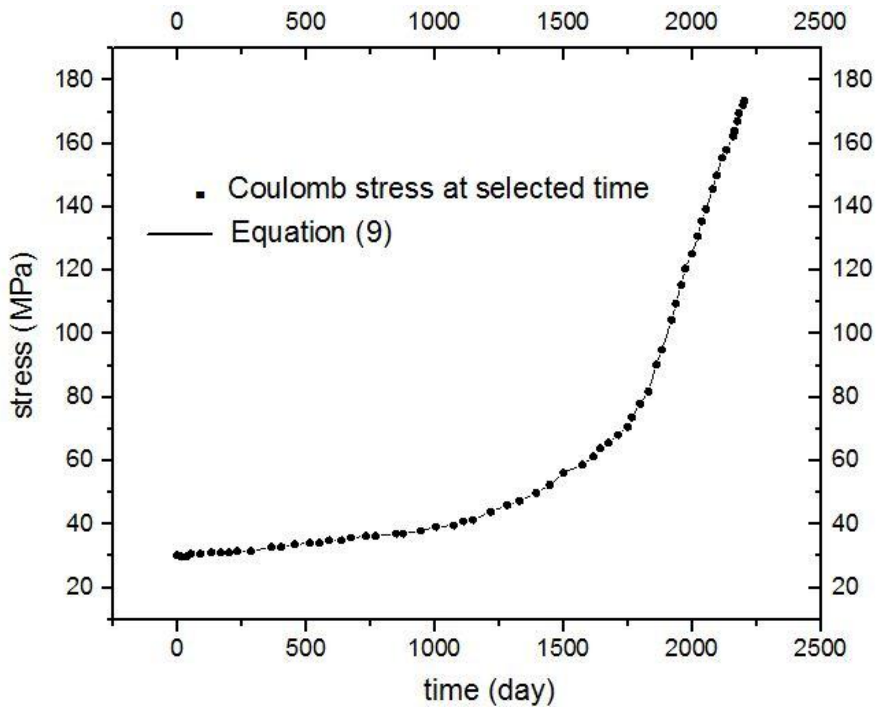


Figure 8. Modified fig. 5 in the article.

So, Eq. (9) in article is rewritten as

$$P(t) = (811.7564794 + 3.069230049t - 0.01424225t^2 + 2.70816 \times 10^{-5}t^3 - 2.0643 \times 10^{-8}t^4 + 5.58076 \times 10^{-12}t^5)^{\frac{1}{2}} \quad . \tag{9}$$

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