The surface length of earthquake fault and the moment magnitude

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We report new formula of relation between moment magnitude (M_w) and surface length of an earthquake fault (L) in estimating strong ground motion of an active fault.

It is difficult to presume the earthquake source fault to the earthquake of the active fault occurred in the period before the observation by the seismograph. Then, the surface length of the earthquake fault is the clearest fault parameter for the active fault in the past. In a case of using the empirical attenuation relation (ex. Si and Midorikawa, 1999) for estimating the strong ground motion, we need information of the shape of the fault plane and M_w. Here, we determined the new formula of the relation between M_w and surface fault length from data of Stirling *et al.* (2002) compiled to the earthquake data until recent. And also, we obtained the formula of the relation between the fault area S and M_w.

Data of Stirling *et al.*(2002) are composed of 389 earthquakes which contain the earthquakes at the data such as Wells and Coppersmith(1994) and recent earthquakes. However, data to lack the reliability of pre-instrument(pre-1900) are contained and some misprints by a basic typing error are seen here and there. Here, after a clear mistake had been corrected, data were selected by the following process.

(a)M_w and L are described with confidence according to the Stirling *et al.*(2002) (242 earthquakes).

(b)M_w is estimated by seismological data (107 earthquakes).

(c)Fault width is described (86 earthquakes).

(d)M_w is almost same degree (within +-0.5) comparing to M_s, M_J, the moment magnitude estimated from surface length or subsurface length of earthquake fault (73 earthquakes).

(e)Mean value of slip displacement on the faults plane is obtained (52 earthquakes).

It is thought that it improves qualitatively as a data set by excluding the earthquake that reliability is lacked though the number of data decreases through these processing.

In this study, we adopted the maximum value of surface length (L) and subsurface length (L_{sub}) (LGTHMX and LGTHMX subs described in the Stirling *et al.* (2002), respectively). Also we adopted the mean value of WMN and WMX in the document as the fault width (W). Moreover, the fault area (S) is calculated from the mean values of some fault lengths and some fault widths as well as this document. Concretely, the mean fault width was multiplied the value of large one of each mean value of the surface length and subsurface length.

Under the processing of (e), dispersion of relation between L and L_{sub} is small over 20 to 30 km of fault length. It is thought that the surface length is underestimated in comparison to the subsurface length.

In consideration of the distribution tendency to data and the research in the past, we divided the data set into less than M_w 6.5 and 6.5 and more for regression analysis. Here, we did not see a remarkable difference by the fault type, therefore, the regression analysis did not adopted the classification of fault type. Results of the regression analysis are followings.

M_w=4.743+1.375logL (1)

M_w=3.560+1.194logS (2)

The formula (1) mostly correspond the relation between M_w and the fault length estimated from fault area assumed as W_{max}=18km in the Recipe of strong ground motions of the Headquarter for Earthquake Research Promotion, in M_w6.5 or more.

Ser	Mw	LGTH	Lsub	Wmn	Wmx	No.	Loc.	Event	Date	typ
1	7.9	432		10	15	88.	SA CA	San-Francisco	18/04/06	S
2	6.62	20	24	15	15	95.	Italy	Avazzano	13/01/15	N
3	8.02	220		20	45	99.	China	Kansu	16/12/20	S
4	6.89	35	22	11	15	108.	Japan	North-Izu	25/11/30	SR
5	7.92	180		20	25	111.	China	Kehetuohai-E	10/08/31	S
6	6.92	60	45	8	11	128.	SA CA	Imperial-Valley	19/05/40	S
7	7.22	58		15	18	155.	Turkey	Canakkala	18/03/53	S
8	6.22	18	11	14	14	158.	Nevada	Rainbow-Mountain	6/07/54	N
9	6.55	34	26	14	14	159.	Nevada	Stillwater	24/08/54	N
10	7.17	57	50	6	15	160.	Nevada	Fairview-Peak	16/12/54	SN
11	6.94	45	42	14	14	161.	Nevada	Dixie-Valley	16/12/54	SN
12	8.14	236	300	20	35	166.	Mongolia	Gobi-Altai	4/12/57	S
13	7.77	200	350	12	16	167.	Alaska	Lituya-Bay	10/07/58	S
14	6.25	38.5	35	7	13	183.	SA CA	Parkfield	28/06/66	S
15	7.03	40	40	15	20	190.	Mongolia	Mogod	5/01/67	S
16	7.34	80	70	15	20	191.	Turkey	Mudurna-Valley	22/07/67	S
17	6.63	31	40	10	13	196.	SA CA	Borrego-Mountain	9/04/68	S
18	7.23	80	110	20	20	198.	Iran	Dashi-e-Bayaz	31/08/68	S
19	6.61	36	20	10	10	199.	Australia	Meckering	14/10/68	RS
20	6.71	30	32	11	11	201.	Turkey	Alasehir-Valley	28/03/69	N
21	7.18	41	63	17	17	209.	Turkey	Gediz	28/03/70	N
22	6.64	16	17	14	20	211.	SA CA	San-Fernando	9/02/71	RS
23	7.47	89	110	13	15	222.	China	Luhuo	8/02/73	S
24	6.55	26		13	13	235.	Turkey	Lice	6/09/75	R
25	7.63	235	257	13	15	239.	Itarnala	Motagua	4/02/76	S
26	7.23	55	90	18	18	248.	Turkey	Caldiran	24/11/76	S
27	5.89	12	14	12	12	255.	IR	Bob-Tangol	19/12/77	S
28	7.39	85	74	27	27	262.	Iran	Tabas-e-Golshan	16/09/78	R
29	5.55	3.9	6	4	4	265.	USA	Homestead-Valley	15/03/79	S
30	6.12	15	16	6	6	267.	Australia	Cadoux	2/06/79	R
31	6.53	30.5	51	8	12	271.	SA CA	El-Centro	15/10/79	S
32	7.17	65	75	22	22	273.	Iran	Koli	27/11/79	SR
33	7.1	31.2	55	15	15	283.	Algeria	El-Asnam	10/10/80	R
34	6.91	38	60	15	15	284.	Italy	South-Apennines	23/11/80	N
35	6.63	15	30	16	16	287.	Greece	Corinth	24/02/81	N
36	6.31	19		16	16	288.	Greece	Corinth	25/02/81	N
37	6.25	13	26	18	18	289.	Greece	Corinth	04/03/81	N
38	6.93	34	33	18	20	303.	Idaho	Borah-Peak	28/10/83	NS
39	5.79	13	13	3	3	327.	Australia	Marryal-Creak	30/03/86	RS
40	5.93	15	15	14	14	334.	GR	Kalamata	13/09/86	N
41	6.5	14	32	14	14	339.	NZ	Edgecumbe	2/03/87	N
42	6.2	10	30	12	12	345.	SA CA	Elmore-Ranch	24/11/87	S
43	6.61	27	30	11	11	346.	SA CA	Superstition-Hills	24/11/87	S
44	6.26	10.2	13	9	9	347.	Australia	Tennant-Creek	22/01/88	R
45	6.38	6.7	13	9	9	348.	Australia	Tennant-Creek	22/01/88	RS
46	6.58	16	19	12	12	349.	Australia	Tennant-Creek	22/01/88	R
47	5.98	10	10	5	5	359.	Canada	Ungava	25/12/89	R
48	7.34	71	62	12	12	372.	SA CA	Landers	28/06/92	S
49	7.4	110	110	20	25	386.	Turkey	Izmit	17/08/99	S
50	7.7	83	83	10	18	387.	Taiwan	Chichi	20/09/99	R
51	7.1	41	41	10	15	388.	California	Hector-Mines	16/10/99	S
52	7.1	30	30	15	15	389.	Turkey	Duzca	12/11/99	S