FIELD INVESTIGATION ON THE DAMAGE OF HOUSING AND INFRASTRUCTURE CAUSED BY EARTHQUAKE IN CENTRAL JAVA, INDONESIA (*Mw*:6.3; May.27, 2006)

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Outline

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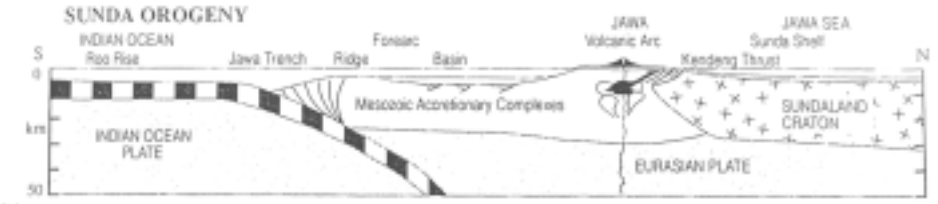
10. Key Issues

Hypocenter & Tectonic



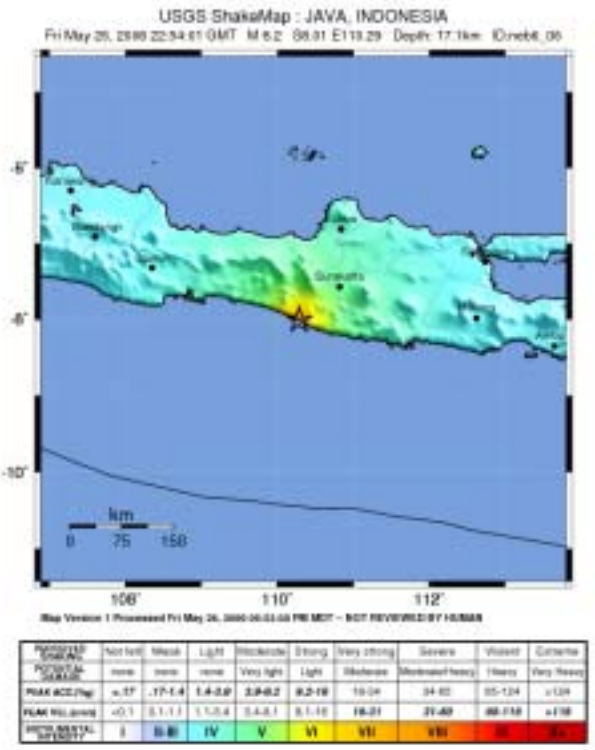
Hall., R. and Blundell. D., 1996.

The Late Neogene Sunda orogeny affected the segment of the Indonesian arc between West Java and the islands of Nusa Tenggara as far east as Flores. In this segment of the arc convergence between the Indian Ocean and SE Asian plates is normal to the subduction trace in the Java Trench with a rate of c. 7 cm/year. The subduction system comprises an accretionary complex composed of offscraped Indian Ocean floor materials in the Java forearc ridge, a forearcbasin developed on extended continental crust and containing late Palaeogene to Recent sediments. The volcanic arc which forms the backbone of Java and formsthe islands to the east is constructed on continental crust in West Java, on Mesozoic accretionary complexes in Central and east Java and on oceanic crust in Sumbawa and Flores.

In Central Java the thrust is cut and disrupted by the Cimandari and Citandui Faults which have wrench components of movement.

Compression may develop when smooth subduction of the down going oceanic plate is interrupted by topographic irregularities on the seafloor.

Hall., R. and Blundell. D., 1996.



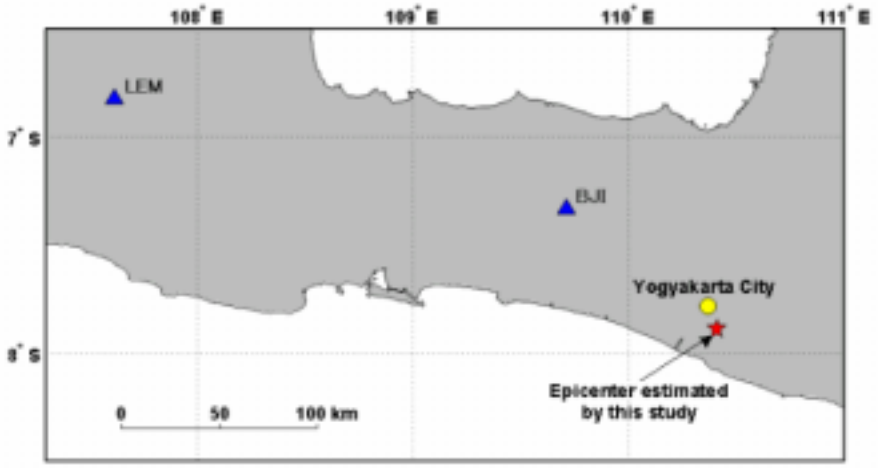
An earthquake with a magnitude of 6.3 occurred at 5:54 AM (local time) on May 27, 2006.

The large earthquake attacked the central Java in the early on Saturday caused 5,700 casualties. We carried out damage investigation on housing and infrastructure, located near the hypocenter, on Java Island. We conducted our investigation from May 5 to 8, 2006.

This figure shows the USGS Shake Map of this earthquake as intensity area. These results indicate that the strong intensity VI is limited within 50 km.

http://earthquake.usgs.gov/eqcenter/recenteqsww/Quakes/quakes_all.php

Waveform data obtained by the Indonesian broadband seismograph network (Realtime-JISNET)

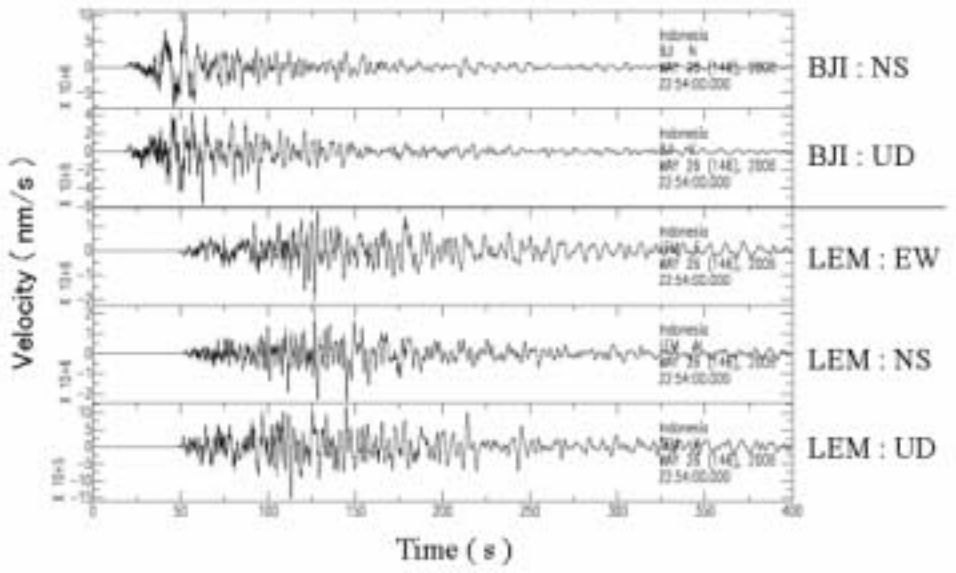


[Source mechanism analysis of the Java earthquake (May 26, 2006) using waveform data obtained by the Indonesian broadband seismograph network (Realtime-JISNET)]

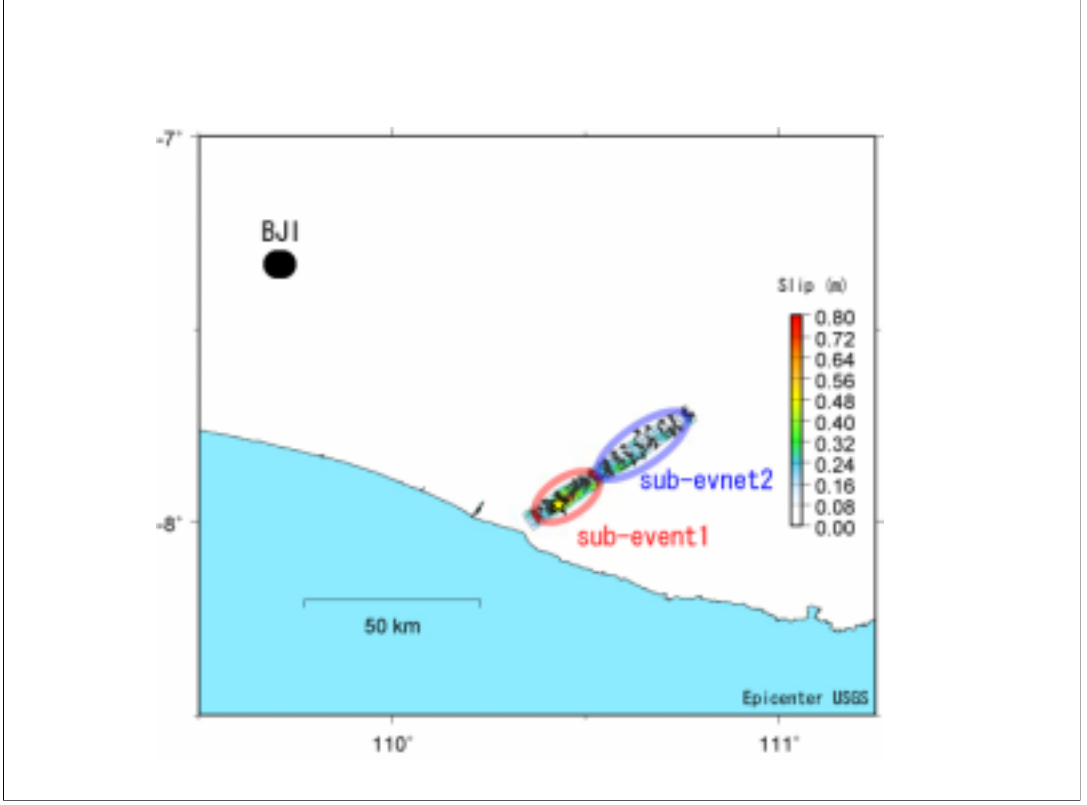
https://relay.n-koei.co.jp/events/YogyaEq_20060526/index2e.html,DanaInfo=www.isn.bosai.go.jp+

NIED estimated the source location and mechanism of this earthquake, using waveform data obtained by the Indonesian broadband seismograph network (Realtime-JISNET) operated by Indonesia Meteorological and Geophysical Agency (BMG) and NIED. These results indicate that the epicenter was located approximately 10 km SSE of Yogyakarta City at a depth of 10 km beneath the surface. The moment magnitude (Mw) was estimated as 6.3.

Waveform data

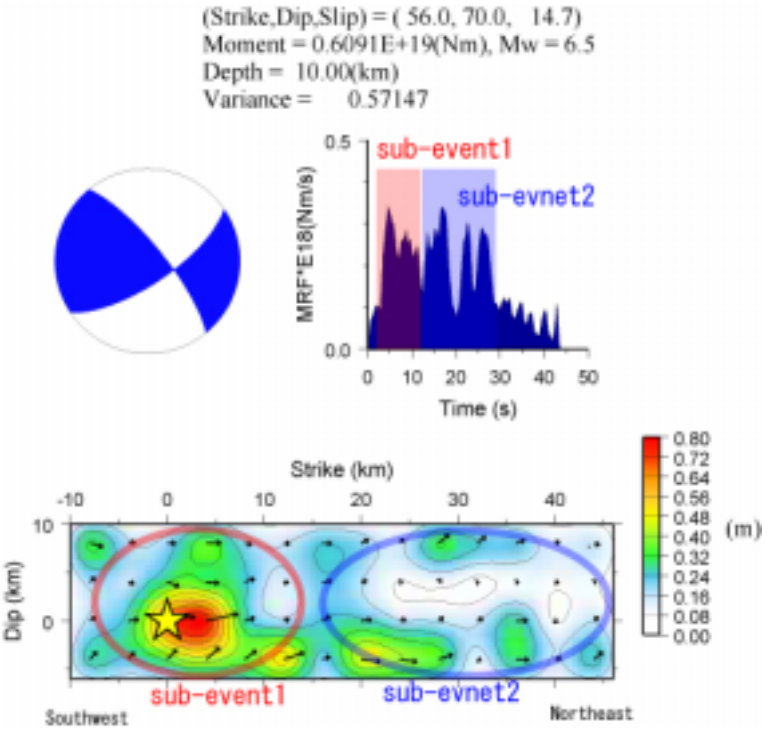


This figure shows three-component waveform data acquired by CMG-3T EBB (0.02-360 s) at BJI (Banjar Negara) and LEM (Lembang) stations of Realtime-JISNET. Waveform data were not available for the EW component at BJI due to a trouble of the seismometer in this component.



According to Dr. Yagi's inversion, in this earthquake case happened rupture in two stages.

In first stage as sub-event1, the rupture direction was expanded to a southwest to northeast and second rupture as sub-event 2 has happened.



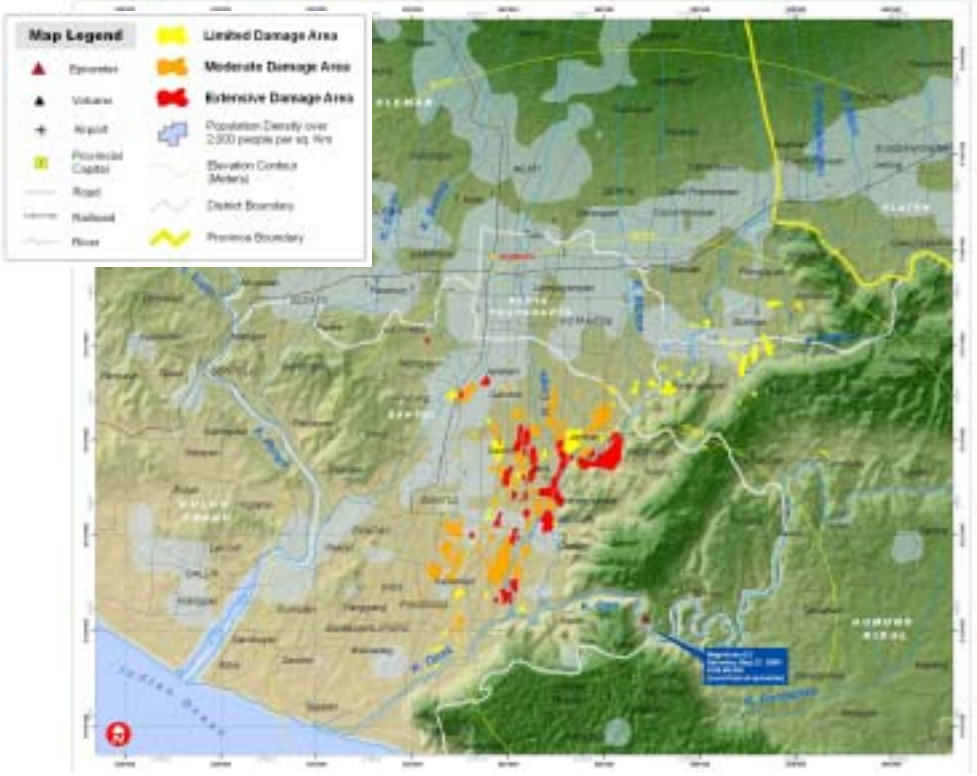
The strike-slip fault which the direction is a southwest to northeast has happened in depth less than 15km.

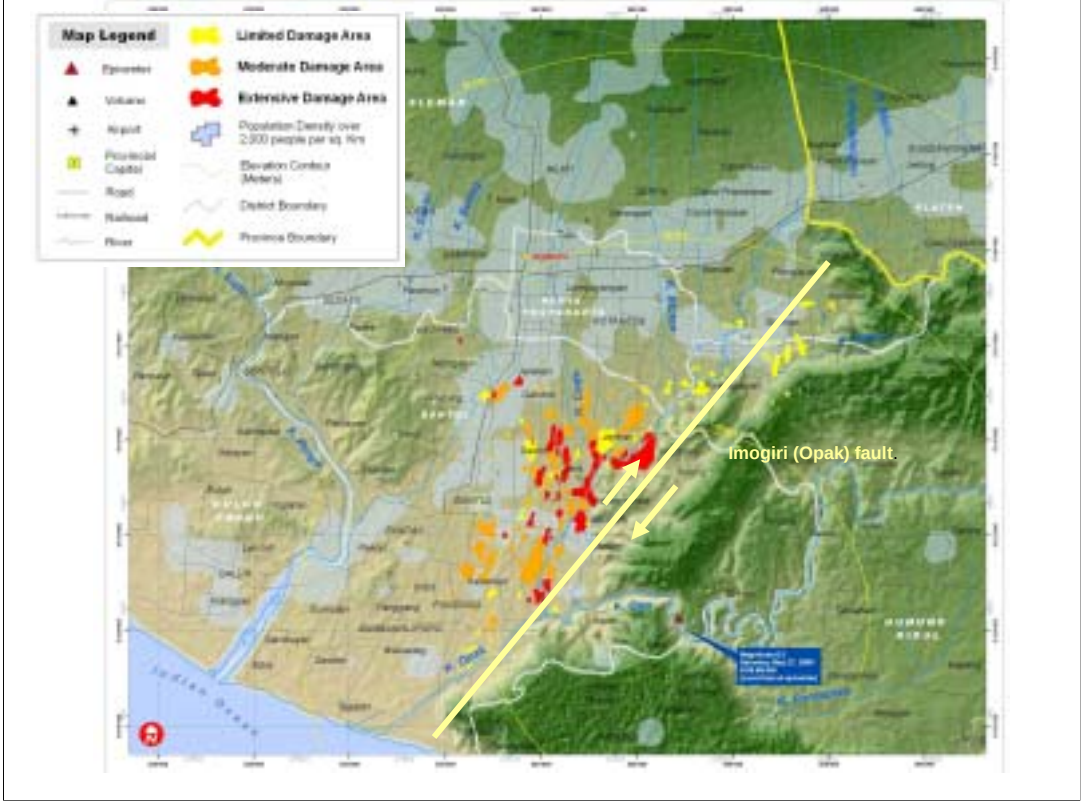
The moment release history is complicated and continuation time also amounts to about 40 seconds.

Even if duration time is assumed at 30 second, it is longer by 2 times than one of an earthquake of Mw6.5 class.

Moreover, the rupture velocity is rather than slow as about 1.4 km/sec. First, sub-event1 occurred 3 seconds, after earthquake and the rupture mainly propagated to the north and the northeast of the hypocenter. And, sub-event2 occurred during the 12 seconds after start earthquake. At this time, rupture mainly spread destruction toward the northeast. Due to directivity effect that the seismic wave is amplified the areas propagating direction have been damaged heavily.

KOMPAS, RABU, 31 MEI 2006


Map Legend
Limited Damage Area
Moderate Damage Area
Extensive Damage Area
Population Density over 2,000 people per sq. Km
Elevation Contour (Meters)
District Boundary
Province Boundary
Epicenter
Volcano
Airport
Provincial Capital
Road
Railroad
River



This UNOSAT map illustrates a preliminary damage assessment of the most affected areas from this earthquake conducted by U.S. movement agencies. According to this map, the extensive damaged area are located in east-side of Bantul prefecture.

We indicate fault line on this map. As seen in the map, extensive damaged areas are spreaded in the west-side of Imogiri (Opak) fault.

Outline of Survey

Date	Route
June 5 (Tue)	JKT-Solo, Candi Prambanan, Janti Fly Over, meeting with Hamengkubuwono X
June 6 (Tue)	BPKP, Sermo Dam, Bantul, Imogiri
June 7 (Wed)	Jrung Peduck Bridge, Gunungkidul,
June 8 (Thu)	Wonogiri Dam, Solo-JKT

Survey Member

1. Mr. Koji Baba
(Jakarta Office General Manager, NK)

2. Dr. Tsuneo Ohsumi
(Disaster Management, NK)

QUAKE VICTIM DATA OF YOGYAKARTA SPECIAL REGION AS OF 12 JUNE 2006 AT 12:00

Location	Victims			Damage (Residential Houses)			Public Facilities								
							Praying Location			School			Government Building		
	Death	Heavily Injured	Lightly Injured	Came Down to the Ground	Heavily Damaged	Lightly Damaged	Came Down	Heavily Damaged	Lightly Damaged	Came Down	Heavily Damaged	Lightly Damaged	Came Down	Heavily Damaged	Lightly Damaged
Bantul	4,141	8,673	3,353	71,683	70,796	66,512				6	85	45			
Sleman	232	690	3,099	5,243	16,003	33,233				67	125	90	11	34	41
Yogya	204	245	73	7,161	14,536	21,192				7	67	85			
Kulon Progo	22	276	2,490	4,527	5,178	8,501	1	20	110	5	108	145		39	57
Gunung Kidul	81		1,086	7,746	10,670	27,130		307		15	75	38		120	
Total	4,680		19,985	96,360	117,183	156,568		438		100	460	403		302	

CENTRAL JAVA	Victims			Damage (Residential Houses)			Public Facilities								
							Praying Location			School			Government Building		
	Death	Heavily Injured	Lightly Injured	Came Down to the Ground	Heavily Damaged	Lightly Damaged	Came Down	Heavily Damaged	Lightly Damaged	Came Down	Heavily Damaged	Lightly Damaged	Came Down	Heavily Damaged	Lightly Damaged
Kabupaten Klaten	1,045		18,127	29,988	62,979	98,552							76	430	439
Kabupaten Magelang	10		24	199	507	658							0	2	1
Kabupaten Boyolali	4		300	307	696	708						108	0	2	1
Kabupaten Sukoharjo	3		67	51	1,808	2,476							6	14	7
Kabupaten Wonogiri	0		4	17	12	74							25	0	0
Kabupaten Purworejo	1		4	10	214	780							0	0	0
Total	1,063	18,526		30,572	66,216	103,248				0	0	108	107	448	448

YOGYAKARTA & CENTRAL JAVA	5,743	38,511		126,932	183,399	259,816	438	100	460	511	1,305

Candi Prambanan

Prambanan temple caused heavy damage on Ciwa and Garuda temple.This temple is located in the 40 km north east of the epicenter.

But this point is located to the end of Imogiri (Opak) fault. It is considered that the seismic wave was amplified by the directivity effect.

Candi Prambanan

Janti Fly Over

Expansion joint of Janti Fly Over unfastened. But this damage is not serious. The fly over is served for traffic.

BPKP

parangtritis km 5

BPKP office, which is located at Parangtrits(the ring load southern part of Yogyakarta from 5 km) is completely damaged in right part by buckling of RC column and cannot be used any more.

Sermo Dam

The Sapan dam, which located in 30 km west from the epicenter, the deformation of crest was estimated at 85cm from record of inclinometer after the earthquake. Final movement is observed at 12 mm. There is no crake in this crest. A seismograph was installed on the embankment, but this instilment was not out of order.

Bantul

In BANTUL prefecture, especially at IMOGIRI, housings are totally clapped.

Bantul

Residents live on the tent for fear of aftershock.

Bantul

Structure of almost all collapsed houses is brick or reinforced concrete frame and burned brick masonry infill wall with cement mortar.

A roof structure is a tile-roofed on wooden mesh.

Imogiri

In IMOGIRI county, this earthquake killed 260 casualties. Among those, at Turi village killed 22 casualties with a population of 700 person.

Patuk

The road-shoulder was collapsed by the earthquake. This point located near the Imogiri fault at Patuk.

Jrung Peduck Bridge

Jrung Peluk Bridge was collapsed in the left side of abutment, which is located near Patuk.

Jrung Peduck Bridge

Expansion joint of Jrung Peluk Bridge was collaped at the left side of abutment.

Gunungkidul

On the seashore Baron in Gunungkidul, covered in the limestone, the eroded overhang cliff was collapsed by the earthquake.

Wonogiri Dam

The Wonogiri dam is far from the epicenter with 60km, and there is no damage. As for neighboring people, the false rumor that a crack went into the dam and became with panic immediately after the earthquake.

Summary of field inspection

- Damaged areas begin Klaten between Solo to Yogyakarta.
- The infrastructure have little damage .
- In Bantul, housings are totally clapped.
- Extensive damaged areas are spreaded in the west-side of Imogiri fault. 。
- Collapsed houses is brick or reinforced concrete frame with cement mortar
- Dam bodies are also good foundation and no damage.

Summary of a dislocation and an earthquake

- Imogiri fault exist on Opak river.
- The strike-slip fault which the direction is a southwest to northeast has happened in depth less than 15km.
- The length of dislocation is 55 km and this dislocation spread toward to northeast at Klaten and Tulung.
- In this earthquake case happened rupture in two stages.
- High frequencies were included in waveform as the seismic source specific character.

Why did the infrastructure have little damage but the housing have much damage?

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One of the reason is that deformation of foundation was a little as the site specific character on foundation geology and the civil infrastructures were not damaged.

As another reason is that high frequencies were included in waveform as the seismic source specific character and it created large acceleration. As the results, low flat houses built by brick and Java traditional roof tile structure which is top heavy structure were broken.

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- As another reason is that high frequencies were included in waveform as the seismic source specific character and it created large acceleration. As the results, low flat houses built by brick and Java traditional roof tile structure which is top heavy structure were broken.

Why did damaged area distribute un evenly?

The extensive damaged areas are located in east-side of Bantul prefecture. Extensive damaged areas are spreaded in the west-side of Imogiri (Opak) fault. Comparison of west- and east-side of fault, west-side is downthrown and east-side is up thrown.The volcanic lava sediments exist in the west side and tuff and claystone are laid in the east side. Thus, the west side of the fault, in which volcanic sediments are not consolidated, was damage seriously.

Moreover, that serious damage in Klaten is considered as follow;

Rupture mainly spread toward the northeast. Due to directivity effect, the seismic wave is amplified propagating direction and then Klaten area have been damaged heavily.

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Key Issues

1) Emergency diagnosis of housings for public facilities, hospitals, and schools are necessary to use a great deal of damaged structures.
2) Effective earthquake resistance method for a masonry structure needs to be developed.
3) The false rumor that tsunami happened or a crack went into the dam became with panic immediately. after the earthquake.

Key Issues

4) A construction system and an execution management system need to be looked again.
5) A water service institution should be installed and a temporary well needs by drilling for ground water.