

2019/5/23

The First JSCE-ASCE Joint Symposium
on Infrastructure Resilience

Countermeasures against Kumamoto Earthquake 2016

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Kumamoto Earthquake 2016

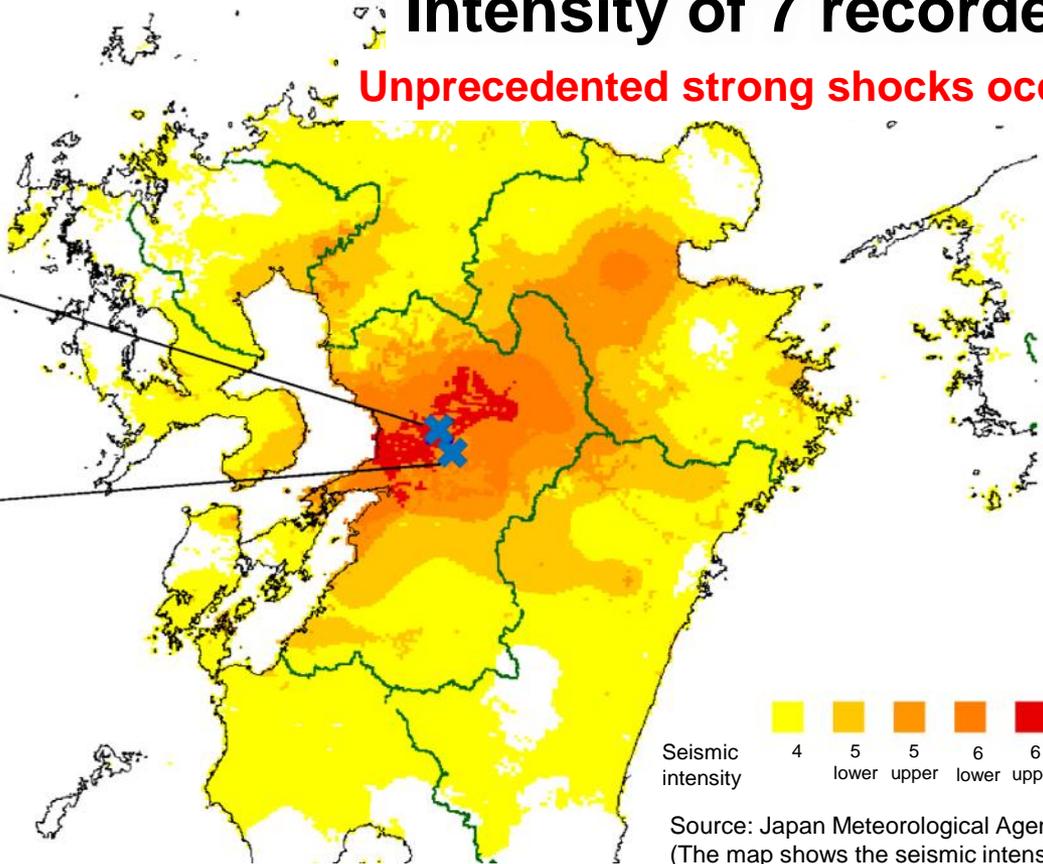
An earthquake of magnitude 6.5 occurred on April 14, 2016 at 9:26 p.m. (foreshock) with the hypocenter in Kumamoto Region. Twenty-eight hours later, at 1:25 a.m. on April 16, another earthquake (main shock) occurred with a magnitude of 7.3, of which intensity was 7 on the Japanese intensity scale. The “Kumamoto Earthquake” caused tremendous damage in Kumamoto, Aso and the surrounding areas, including those from aftershocks that occurred more than 4000 times in total.

Seismic intensity map

Intensity of 7 recorded twice
Unprecedented strong shocks occurred in series

April 16, 1:25 a.m.,
M 7.3, maximum seismic intensity 7

April 14, 9:26 p.m.,
M 6.5, maximum seismic intensity 7



Seismic intensity 4 5 lower 5 upper 6 lower 6 upper 7

Source: Japan Meteorological Agency (The map shows the seismic intensity distribution of the earthquake on April 16)

Tremendous Damage Occurred

Tremendous damage occurred also on transportation infrastructures such as an airport, roads and railways, in addition to human damage caused by collapse of many houses and landslides and damage on essential utilities such as electricity, gas and water supply. Thus, the earthquake caused immense problems to prefectural residents and to the economy such as small and medium-sized companies, agriculture, forestry and fishery, and tourism.



Mashiki Town (April 23, 2016)

○ Earthquake fatalities

Directly related 50

Indirectly related 212

* As of April 13, 2018,
Fire and Disaster Management
Agency

○ Damaged houses

Not less than 200,000

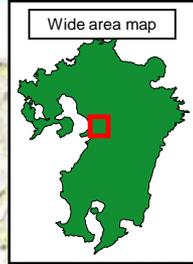
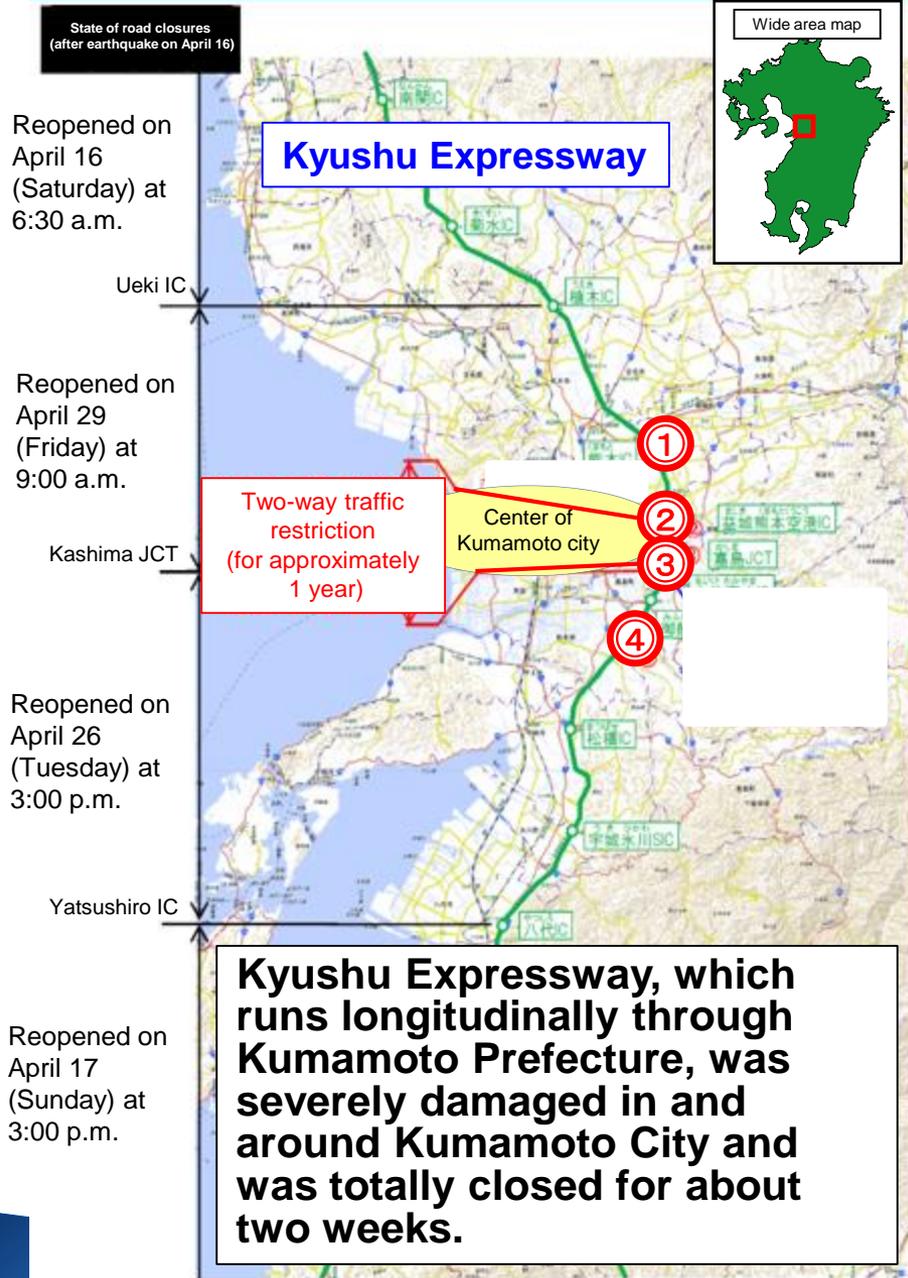
○ Evacuated residents (peak number)

Not less than 180,000

○ Damage to traffic infrastructure

- Kyushu Shinkansen
- Kyushu Expressway
- Kumamoto Airport
and others

Damage to Kyushu Expressway



(1) Inclined bridge columns

被災状況

跨道橋撤去状況 (4/25時点)

(2) Collapse of road embankment

被災状況

復旧状況(4/25時点)

(3) Disconnected bridge beams

被災状況

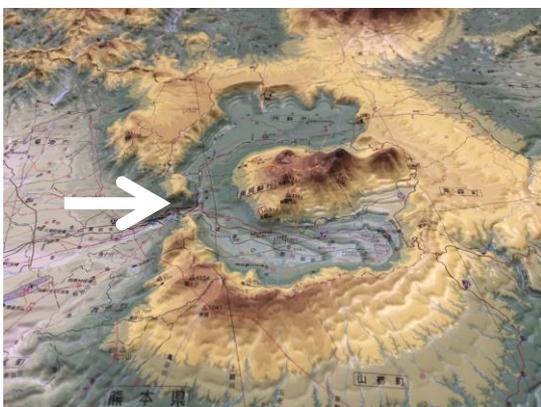
復旧状況(6/18時点)

(4) Collapse of overpass

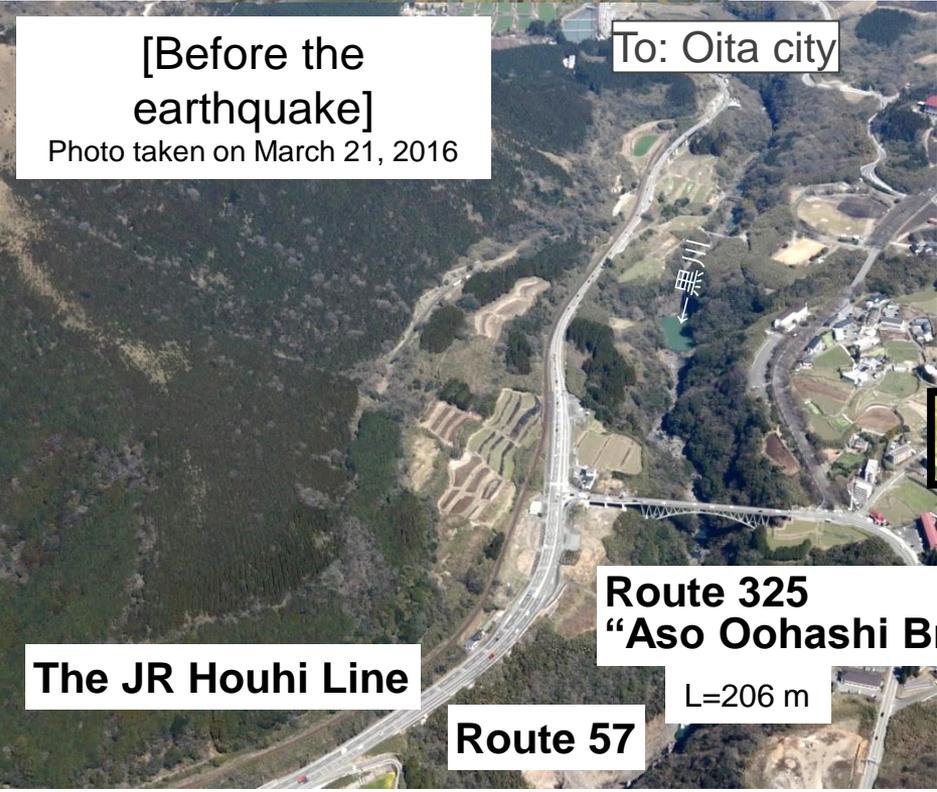
被災状況(高橋)

復旧状況(4/22時点)

Large-Scale Slope Failure and Severed Major Traffic Routes



The main shock on April 16 caused a large-scale slope failure 700 m long and 200 m wide in Minami-Aso Village (the entrance part on the west side of Aso Caldera) and severed Route 57, a major road connecting Kumamoto, Aso and Oita, and the JR Houhi Line. "Aso Ohashi Bridge" of Route 325 that connects the road to Route 57 also collapsed.



[Before the earthquake]
Photo taken on March 21, 2016

To: Oita city

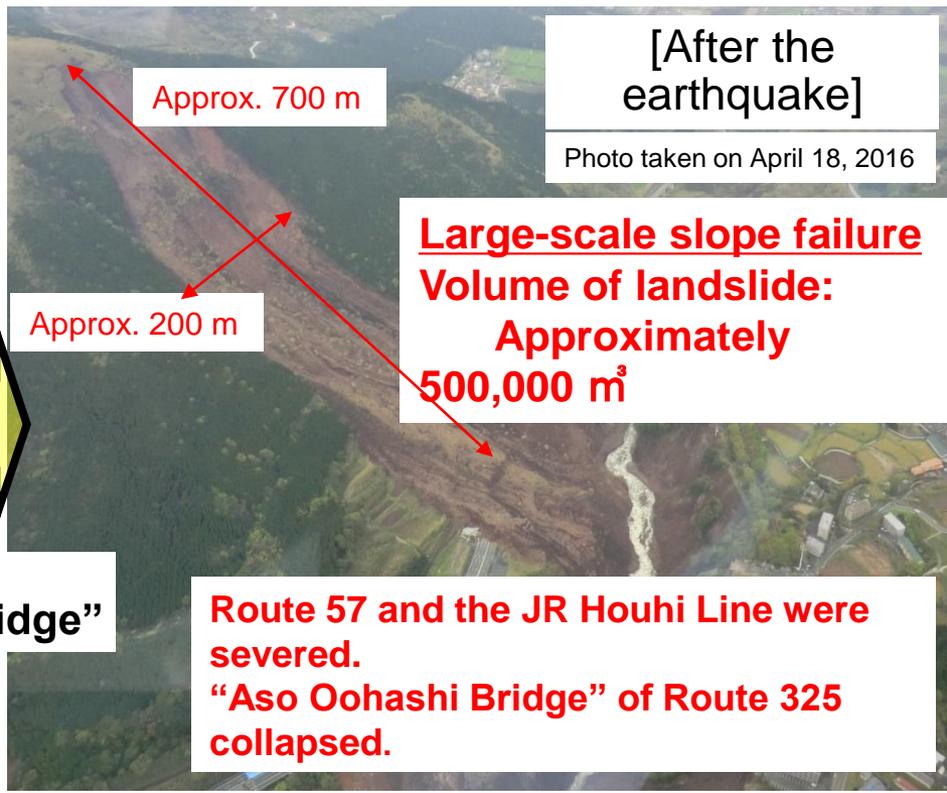
The JR Houhi Line

Route 325
"Aso Ohashi Bridge"

L=206 m

Route 57

To: Kumamoto city



[After the earthquake]
Photo taken on April 18, 2016

Approx. 700 m

Approx. 200 m

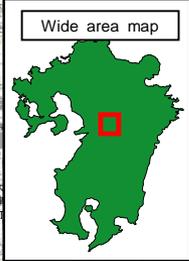
Large-scale slope failure
Volume of landslide:
Approximately
500,000 m³

Route 57 and the JR Houhi Line were severed.
"Aso Ohashi Bridge" of Route 325 collapsed.

Minami-Aso Village (the entrance part on the west side of Aso Caldera)

Devastation Situation of Major Roads between Kumamoto and Aso

Furthermore, prefectural road Kumamoto-Takamori Line (Tawarayama Tunnel and a group of long bridges) and Aso-Chouyo Oohashi Bridge (village road) were severely damaged, paralyzing traffic of more than 20,000 to 30,000 vehicles per day.



Route 57



To: Takamori Town

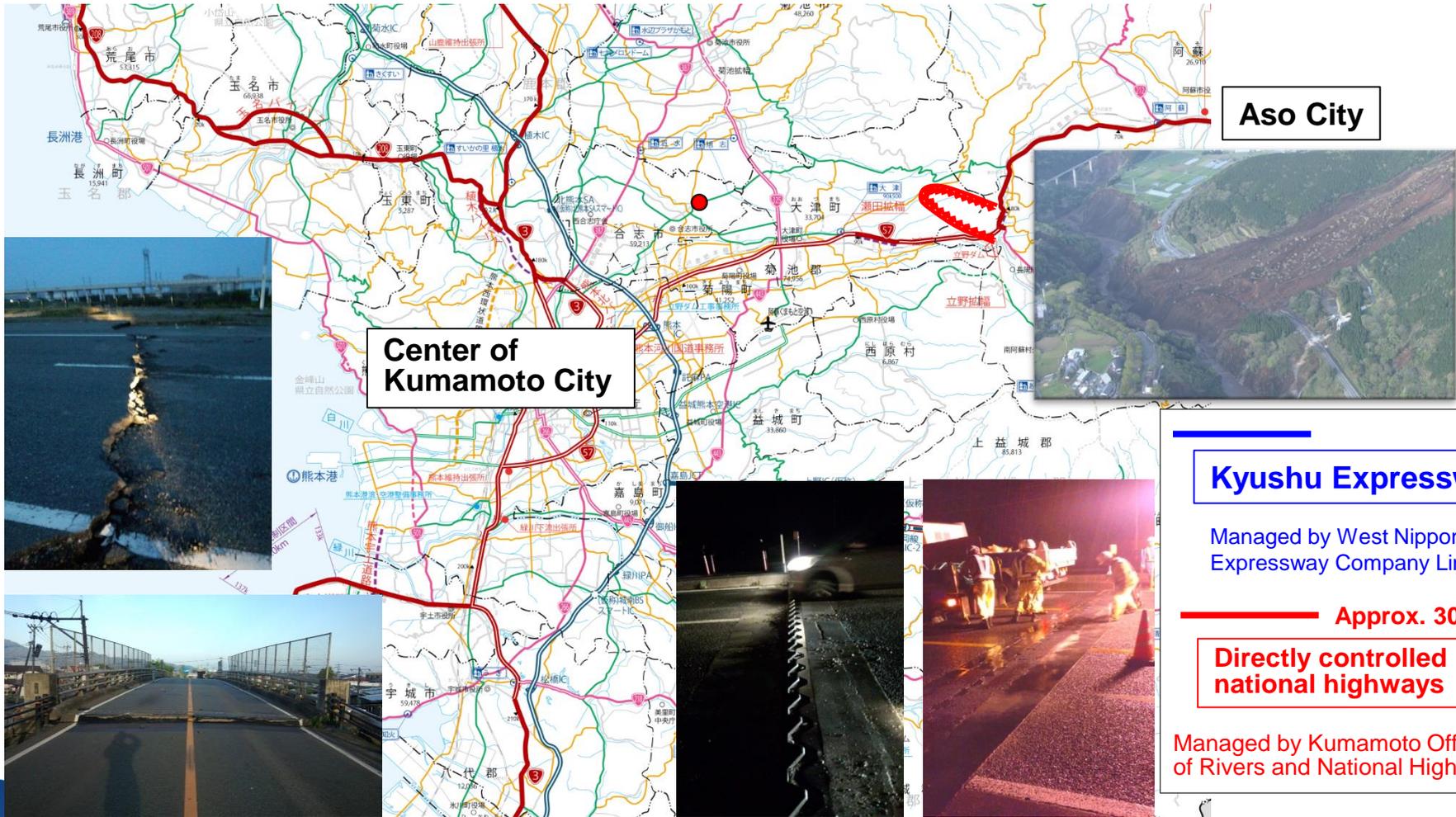
TEC-FORCE Dispatched

A team of disaster countermeasure specialists consisting of staff members of the Regional Development Bureau, etc., of the Ministry of Land, Infrastructure, Transport and Tourism was dispatched to affected sites such as collapsed roads, slopes and damaged bridges. This emergency disaster countermeasures team with approximately 440 members, named **TEC-FORCE** (Technical Emergency Control Force), started the damage survey on April 22. After the occurrence of the disaster, the total man-days of the dispatched members reached approximately 8,200 by May 31 and such a quick implementation of the survey contributed to the early completion of emergency restoration.



Road Restoration by National Highway Office (1) 24 hours after the earthquake

Because Kyushu Expressway was totally closed for about two weeks after the earthquake, securing of traffic on national highways, which run parallel with the expressway and are under direct control of the National Highway Office, became a top priority issue. The main shock of April 16 **also caused severe damage, such as sinkholes on road surfaces and bumps near bridges, on the direct-controlled national highways. However, all emergency restoration was completed to allow normal traffic within 24 hours after the main shock, except one site damaged by the large-scale slope failure (Route 57 in Minami-Aso Village).**



Kyushu Expressway

Managed by West Nippon Expressway Company Limited

Approx. 300 km

Directly controlled national highways

Managed by Kumamoto Office of Rivers and National Highways

Road Restoration by National Highway Office (2)

One or two weeks
after the earthquake

State of devastation

April 16 (Sat)



Road severed by derailment of a train

April 16 (Sat)



[Helicopter position] Aso City, Kumamoto Pref.
[Photographing position] Aso City, Kumamoto Pref.

Condition of emergency restoration work of Route 57 detour



Key

- ⊗ Damaged site location
- ✗ Road closure point



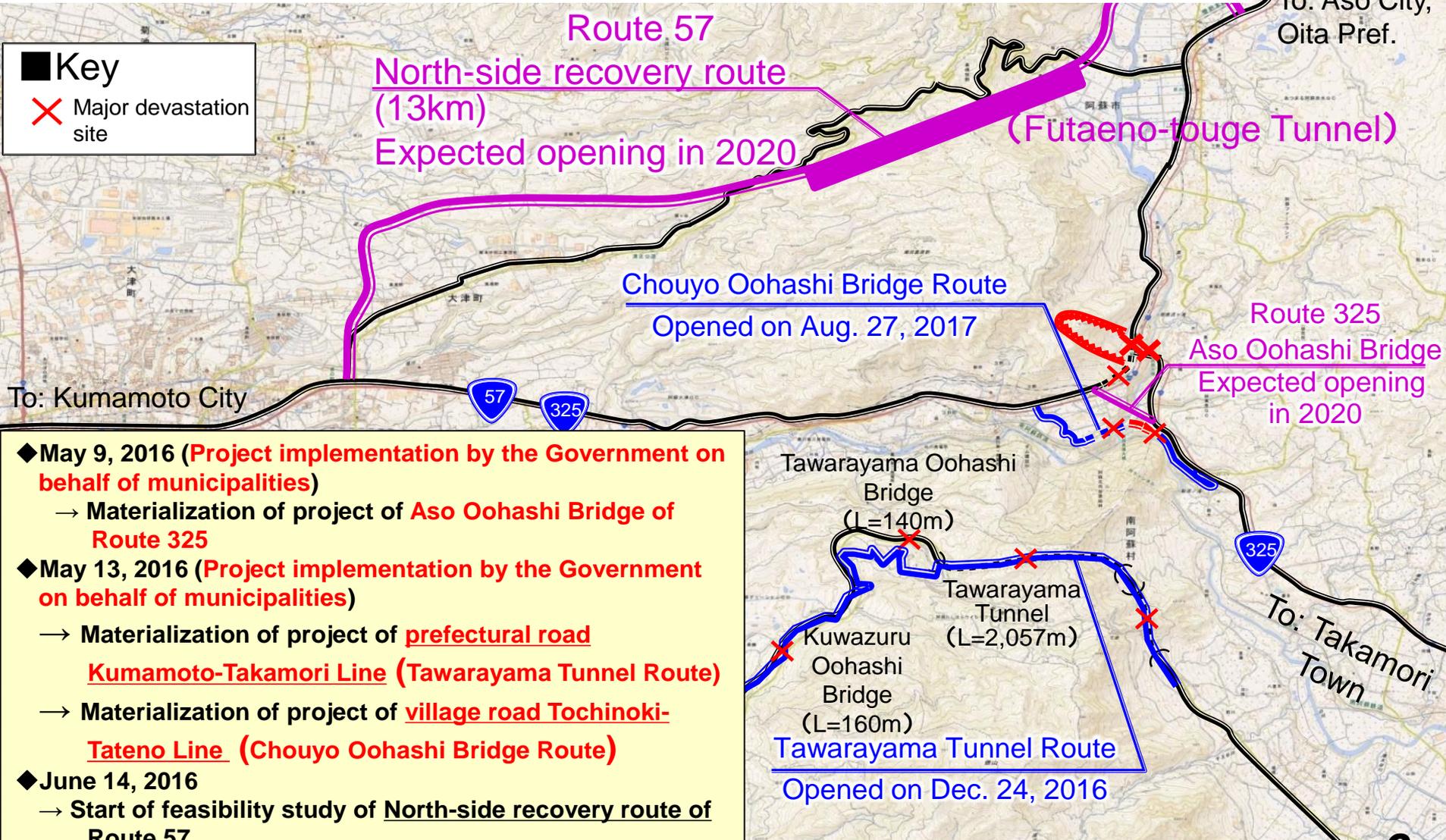
Completed restoration work

April 18 (Mon)



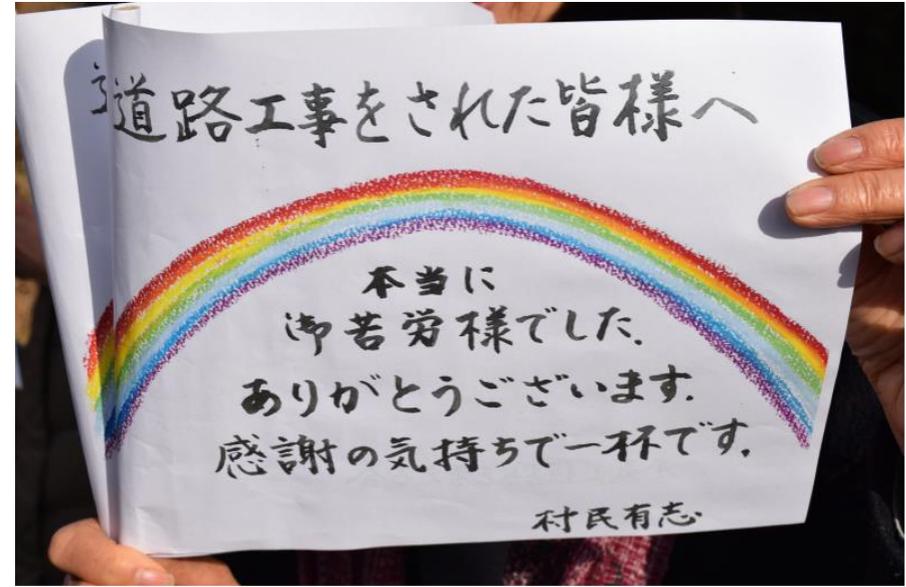
As a detour route for Route 57, which was closed by a landslide, restoration of damaged parts of the prefectural road was expedited and ordinary vehicles (except large-sized or heavy-duty vehicles) could use the road two days after the earthquake. In addition, we helped (partly took over) the emergency restoration work of national and prefectural roads managed by Kumamoto Prefecture to support emergency medical services/rescue activities, transportation of critical materials and restoration of the residents' daily lives.

Complete restoration operation within 5 years after earthquake



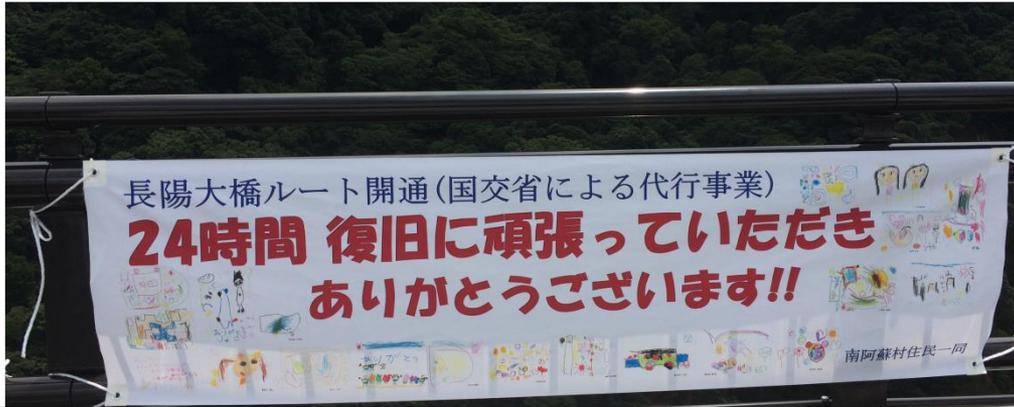
- ◆ May 9, 2016 (Project implementation by the Government on behalf of municipalities)
 - Materialization of project of **Aso Oohashi Bridge of Route 325**
- ◆ May 13, 2016 (Project implementation by the Government on behalf of municipalities)
 - Materialization of project of **prefectural road Kumamoto-Takamori Line (Tawarayama Tunnel Route)**
 - Materialization of project of **village road Tochinoki-Tateno Line (Chouyo Oohashi Bridge Route)**
- ◆ June 14, 2016
 - Start of feasibility study of **North-side recovery route of Route 57**

Opening of Tawarayama Tunnel Route (December 24, 2016)



Factors contributing to the early opening of Tawarayama Tunnel Route, which was highly appreciated as “the best Christmas gift”, were understanding and cooperation of landowners and authorities concerned, hard work round-the-clock by contractees and the management ability of in-house engineers.

Opening of Chouyo Oohashi Bridge Route (August 27, 2017)



* "Kumamoto Reconstruction Project Office" was established in April 2017 and is currently responsible for all post-disaster restoration projects, except the one for "Route 57 North-side Recovery Route (handled by the Kumamoto Office of Rivers and National Highways)".

Key Factors for Post-disaster Restoration Project Management

(1) Alliance with local construction industry 1)

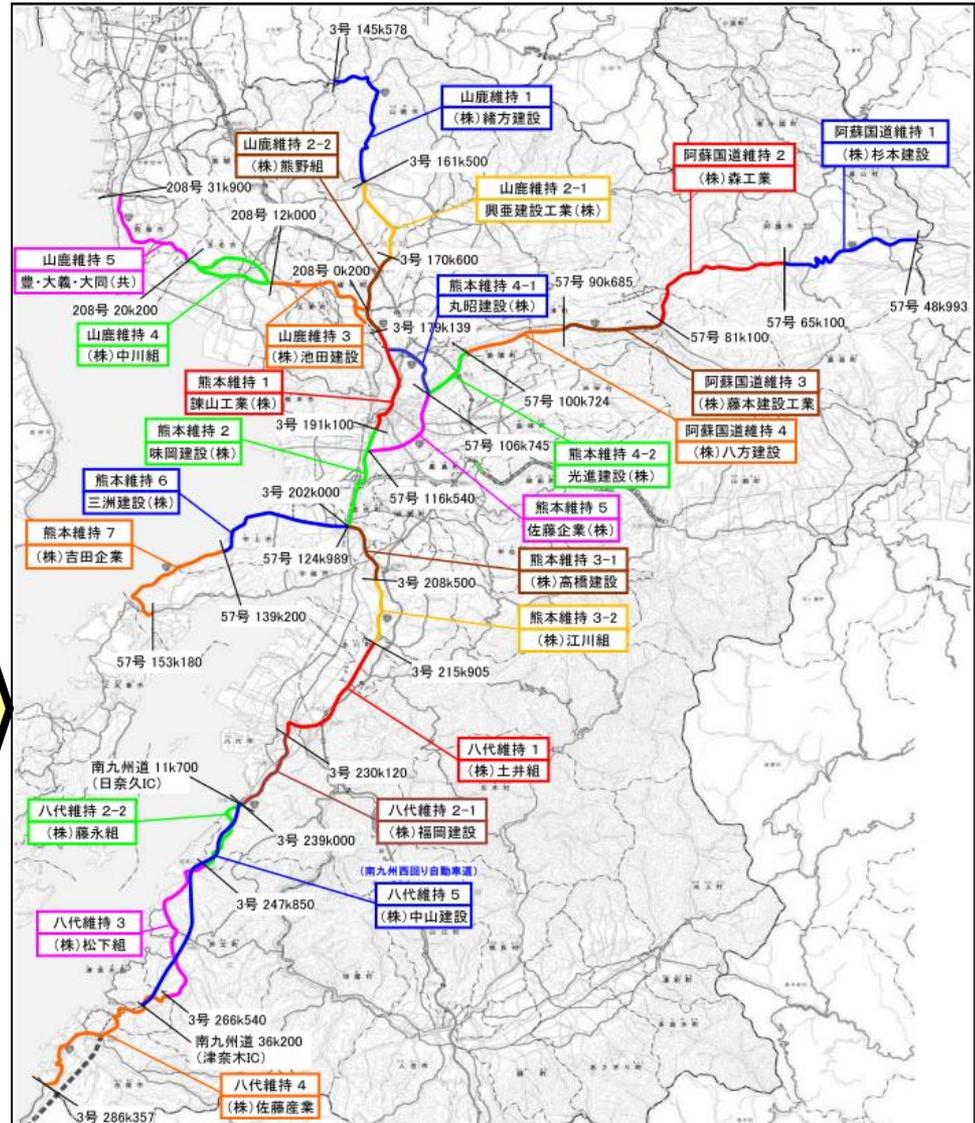
➤ It is necessary to continue giving instructions for the start of construction/services to partners, who jointly implement post-disaster restoration projects (construction companies, field surveyors, design consultants), without hesitation soon after damage occurs.

Instructions based on premise of negotiated contract

➤ By making “Agreement for emergency restoration upon occurrence of disaster” beforehand, possibilities for smooth and quick implementation of post-disaster restoration project become promising.

Basic Agreement for Emergency Restoration upon Occurrence of Disaster (2016)

* The construction company that will be dispatched upon occurrence of a disaster has been nominated for every section of 10 to 15 km of national highways (approximately 300 km), which is managed by the Kumamoto Office of Rivers and National Highways.



(1) Alliance with local construction industry 2)

To execute contractee's responsibility more than during normal times

- To place an order suitable for the circumstances, namely, without too strict adherence to bidding and contracting rules that are applicable under normal circumstances but with adequate understanding of the actual situation of the local construction industry
- After the contract is made, the contractor and contractee cooperatively make efforts to achieve challenging time-schedule-related goals by addressing any issues they face.
- Revisions of the contract are made more carefully than normal by taking actual site conditions into consideration.

(2) Project implementation by Government on behalf of municipalities

- Among post-disaster restoration projects of any municipality, critical ones (which involve massive damage and require high-level technology for restoration, and of which belated implementation may cause severe damage to the area) are taken over by the Government as projects to be implemented on behalf of the municipal government, so that they can be accomplished in a timely manner under the management system of the Ministry of Land, Infrastructure, Transport and Tourism.
- In Kumamoto, three large-scale post-disaster restoration projects were assumed by the Ministry of Land, Infrastructure, Transport and Tourism in response to the request by the Governor of Kumamoto Prefecture and the Chief of Minami-Aso Village. Among them, the opening of Tawarayama Tunnel Route (Dec. 24, 2016) and the opening of Chouyo Oohashi Bridge Route (Aug. 27, 2016) had a strong impact on the area looking to recover from the earthquake.

(3) Enhancement of organization and office staff

- An appropriate size of PM structure staffed with in-house engineers having high-level empirical knowledge shall be established. Especially, staffing of managers such as project managers (PMr) and assistant project managers is a key issue for success of post-disaster restoration projects.
- In the case of Kumamoto, it was fortunate that a series of project management tasks could be handed off to PMr (Director, Promotion Office for Measures against Kumamoto Earthquake Disaster) and Deputy Director, who are both **in-house engineers having the ability to make immediate technical determinations/decisions on-site**. The fact that the challenging work was entrusted to them with confidence was an important key that led the post-disaster restoration project succeed.

(4) Involvement of companies having high-level construction technology from early stage

- For restoration work of large-scale structures, etc., early deployment of construction companies that have specialized skills and high-level management ability is critically important.
- In the case of Kumamoto, contracts for restoration work of Tawarayama Tunnel and several long bridges were concluded on a negotiation basis with major general contractors and bridge construction companies.

(5) Sensitivity and behavior of Director, National Highway Office



As a Site Manager on the Front Line

(1) Thorough communication with key personnel

To secure a hotline with responsible persons in various fields such as the Governor of Kumamoto Prefecture (General Manager for civil engineering), Chief of municipal government, Diet members, a representative of the construction industry and so on

(2) Agile judgement and action

To establish rules and to take action boldly and quickly in “an emergency mode” with due consideration for instructions by superagencies → Prioritization of road restoration, selection of construction company, etc.

(3) To securely maintain motivation of staff members

To develop an atmosphere in which all staff members of the office diligently work with a sense of mission of “for disaster victims in the area and Kumamoto Prefecture”

**Director’s cheerful expression on his/her face
and words of “Thank you”**

(0) My understanding about “**Japanese land and Infrastructure**” since before the Kumamoto Earthquake



- **Japan is vulnerable to natural disasters.**
→ **Serious disadvantage compared to advanced nations such as the U.S. and European nations**
- **Under such geological conditions, Japanese citizens have frequently experienced serious natural disasters, but have overcome all difficulties therefrom.**
- **Infrastructures such as roads are very important for the lives of the people.**
- **The current life of everybody is supported by infrastructures built and renewed by predecessors. Thus, we, the current generation, have an obligation to enhance such infrastructures so that we can hand them over to the future generation.**

END

