Sasago Tunnel Ceiling Collapse on the Chuo Expressway (Sequence of Events and Countermeasures)

Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan
Sasago Tunnel Ceiling Collapse: Incident Summary

- **Date**: Sunday, December 2, 2012 at 8:03am
- **Location**: Tokyo-bound Sasago Tunnel
- **Incident**: 130-meter-section of ceiling panels fell at 1.7km from the east portal of the 4.7km-long tunnel, crushing three vehicles and catching two of those on fire. Nine people were killed and two others were injured.
- **Road closure**: Both the in-bound and out-bound roads were closed until the re-opening of the out-bound lanes for all traffic at 1pm on Dec.29th. All lanes in both directions were re-opened on Feb.8th.

**Incident Location**

Sasago Tunnel (Tokyo-bound)

**Structure of Sasago Tunnel**

- **B-type panel**
  - 5,010 x 1,195 x 90mm
  - 1.385 t/panel
- **A-type panel**
  - 5,010 x 1,195 x 80mm
  - 1.16 t/panel

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**Images of the Incident**

- **As of 12pm Dec. 2**
- **As of 3:30pm Dec. 3**
- **Fallen panels are being removed**
Sasago Tunnel Ceiling Collapse: MLIT’s Response

MLIT’s system for the incident

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 2nd</td>
<td>9:00 On the alert (disaster on road)</td>
</tr>
<tr>
<td>Dec. 2nd</td>
<td>11:30 Chuo Expressway Sasago Tunnel Incident Task Force was formulated (chaired by Naoyoshi Sato, Vice-Minister of Land, Infrastructure, Transport and Tourism)</td>
</tr>
<tr>
<td>Dec. 3rd</td>
<td>14:45 The 3rd meeting of the Task Force was held.</td>
</tr>
</tbody>
</table>

MLIT’s action

<table>
<thead>
<tr>
<th>Date</th>
<th>Action</th>
<th>【Sasago Tunnel】</th>
<th>【Tunnels Across the Country】</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 2nd</td>
<td>15:27 Minister’s instruction in response to the incident</td>
<td>• All efforts toward victims relief activities</td>
<td>• Immediate identification of the causes and preparation for urgent inspection</td>
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<td></td>
<td>• Immediate identification of the causes and preparation for urgent inspection</td>
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<tr>
<td>Dec. 3rd AM</td>
<td>14:00 Site investigation by Minister</td>
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<td>Order of urgent inspection of tunnel ceiling panels</td>
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<tr>
<td>Dec. 4th</td>
<td>14:00 “Research &amp; examination committee for tunnel ceiling collapse incident” was formulated and held</td>
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<tr>
<td>Dec. 6th</td>
<td>14:00 “Liaison committee for Chuo Expressway closure” was formulated and held</td>
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<td></td>
<td></td>
<td></td>
<td>(MLIT (Kanto Regional Development Bureau and Kanto District Transport Bureau), Yamanashi Prefectural Police, Yamanashi Prefectural Development office and Central NEXCO)</td>
</tr>
<tr>
<td>Dec. 7th</td>
<td>14:00 Additional minister’s instruction in response to the incident</td>
<td></td>
<td>Order of general inspection of road tunnel facilities</td>
</tr>
<tr>
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<td></td>
<td>• Road facilities in tunnels, in addition to ceiling panels in all similar tunnels with suspended ceilings</td>
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<td></td>
<td></td>
<td>• Immediate examination of the safety measures, traffic solutions and prospects for reopening the outbound tunnel</td>
<td></td>
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<tr>
<td>Dec. 8th</td>
<td>14:00 Report on the prospect for reopening the Sasago Tunnel (out-bound)</td>
<td>• Safety is ensured by removing out-bound tunnel ceiling panels</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• To be opened to both directions of traffic using the out-bound tunnel</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• To be reopened by the end of the year</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Event Description</td>
<td></td>
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</table>
| Dec. 13th, 17th | **Urgent inspection of tunnel ceiling panels: announcement of results**  
• Found defects in 16 out of 59 tunnels, except for the Sasago tunnel on the out-bound section of the Chuo Expressway. None of them were considered critical by road administrators  
• 632 defects were linked to anchor bolts used to secure the ceiling panel in the out-bound Sasago Tunnel, which was safely secured after removal of the ceiling panels. |
| Dec. 21st | **The 2nd “Research & examination committee for tunnel ceiling collapse incident” was held.**                                                                                                                                                                                                                                                |
| Dec. 27th | **General inspection of road facilities in tunnels: announcement results**  
• Found heavy structure defects in 22 out of 1,420 tunnels. None of them were considered critical by road administrators.                                                                                                                                                                       |
| Dec. 29th | **reopening of out-bound Sasago Tunnel**  
• reopening of the road using the out-bound section for both directions of traffic at 1pm on Dec. 29th.                                                                                                                                                                                |
| Jan. 9th, 2013 | **Announcement of additional results from urgent inspection**  
• Found 1,028 defects with anchor bolts used to secure the ceiling panel in the in-bound Sasago Tunnel, which was safely secured after removal of the ceiling panels.                                                                                                                                 |
|             | **Announcement of in-bound Sasago Tunnel estimated reopening**  
• Progress from the temporary use of the out-bound section for both directions of traffic, to reopening both the in-bound and out-bound sections with 2 lanes of traffic on each is expected to be made in late February.                                                                                                           |
Nationwide Urgent Inspection of Tunnel Ceiling Panels (ordered Dec. 3\textsuperscript{rd}, results released Dec. 13\textsuperscript{th})

**Inspection**

- **Target:** Tunnels with ceiling panels suspended by metal fitting for hanging (segments with the ceiling)
- **Items:** Metal fitting for hanging & fixing bracket, soundness of concrete lining near the anchored metal fitting for hanging, deformation/damage of ceiling panels
- **Method:** Close visual inspection, sound check with hammers and palpation (inspection will be conducted behind the ceiling panels in the structure of upper tunnel)

**Findings (Dec. 13 release, except for Jan. 9 findings for in-bound Sasago Tunnel inspection)**

<59 tunnels, except both directions of Sasago Tunnel on Chuo Expressway>

- Found defects in 16 tunnels, but none of them were critical. Repairs were carried out immediately (or are planned to be carried out)

<Out-bound Sasago Tunnel on Chuo Expressway>

- Found 632 anchor-bolt-related defects. Tunnel’s safety was secured by removing the ceiling panels

<In-bound Sasago Tunnel on Chuo Expressway>

- Found 1,028 anchor-bolt-related defects. Tunnel’s safety was secured by removing the ceiling panels

### Number of tunnels with suspended ceiling panels

<table>
<thead>
<tr>
<th>Maintained by</th>
<th>Number of tunnels</th>
<th>Number of defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>East NEXCO</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Central NEXCO</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>West NEXCO</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Metropolitan Expressway Company</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Hanshin Expressway Company</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>National Government</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Pref/Ordinance-designated cities/Road corporations</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>59</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

※Excludes the Sasago Tunnel (both bounds) on the Chuo Expressway.
※Independent tunnels for both directions are counted separately.
※Excludes tunnels with ceiling panels that are anchored at the both ends.
※Inspection findings of 2 tunnels managed by Yamanashi Pref were released Dec 17\textsuperscript{th}.

### Defects found in Sasago Tunnel

- **T-shaped steel**
- **Anchor bolt loose**
- **Bolt loss**
- **Metal fitting for hanging**
- **Lining**
- **T-shaped steel**
- **Bulkhead**
- **Lining concrete cracking**
- **Cracking of lining concrete**
General Inspection of Road Facilities in Tunnels (ordered Dec. 7th, results released Dec. 27th)

<table>
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<tr>
<th>Inspection</th>
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<tr>
<td><strong>Target</strong>: Road facilities anchored with anchor bolt in the tunnel space (lighting, signage, jet-fan, warning sign, sound insulation board, other objects)</td>
<td></td>
</tr>
<tr>
<td><strong>Items</strong>: Damage or abnormality of anchor bolts &amp; nuts, joint and other accessories</td>
<td></td>
</tr>
<tr>
<td><strong>Method</strong>: Close visual inspection, sound check with hammers and palpation</td>
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</tr>
<tr>
<td><strong>Deadline</strong>: Heavy facilities (jet-fan and road signage) Wednesday, December 26, 2012 Other accessories Friday, March 22, 2013</td>
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</tbody>
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Findings (heavy structures such as jet-fans and road signs)

- <Of the 1,420 tunnels inspected, excluding 15 tunnels to be inspected in the future due to weather and traffic restrictions>
  Defects found in 22 tunnels, but none of them were critical. Repairs were carried out immediately (or are planned to be carried out).

### Inspection Findings

<table>
<thead>
<tr>
<th>Maintained by</th>
<th>Number of tunnels with defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressway Companies</td>
<td>9</td>
</tr>
<tr>
<td>National Government</td>
<td>9</td>
</tr>
<tr>
<td>Prefecture/Ordinance designated cities</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22</strong></td>
</tr>
</tbody>
</table>

※ Independent tunnels for both directions are counted separately
※ Excludes inspections for other facilities
※ Excludes in-bound Sasago Tunnel that caused the incident

### Typical inspection of jet-fans in tunnel

Metal fitting for hanging

Jet-fan inspection
Road Tunnel Inspection: additional information

■ Road Tunnel Techniques Standard [Nov. 1974 (revised in 1985 and 1989) Director-generals of City Bureau and Road Bureau, Construction Ministry]

Prior to actual tunnel maintenance/repair work, inspection/maintenance manual shall be prepared. The actual work should comply with the relevant laws and regulations. Inspectors’ security should be ensured during work.

■ Road tunnel maintenance guide [1993 Japan Road Association]
Prepared by the Japan Road Association as a technical guide for road administrators to formulate an inspection/maintenance manual.

■ Central NEXCO’s inspection/maintenance manual (structure section) [Apr. 2012]

【Daily inspection】Visual inspection from a patrol vehicle for 4 to 7 days every 2 weeks

【Basic inspection】Remote or close visual inspection to review the condition of entire structure at least once a year (further inspection depending on the situation)

【Detailed inspection】Close visual inspection and sound inspection with hammers to review the condition of structural soundness once every 5 to 10 years.

【Emergency inspection】Inspection to review the structure condition in the event of an earthquake or other disaster, depending on the situation.

Note: “basic inspection” and “detailed inspection” together are called a “periodical inspection.”
“Research & Examination Committee for Tunnel Ceiling Collapse Incident”

In response to the tunnel ceiling collapse incident that took place on Dec. 2nd 2012, the “Research & examination committee for tunnel ceiling collapse incident” was launched to identify the cause of the collapse and to discuss preventive measures of recurrence.

**Member**
- **Chair** Tooru Konda  Emeritus professor at Tokyo Metropolitan University (Doctor of Engineering)
- Kazuo Nishimura  Professor at Tokyo Metropolitan University (Doctor of Engineering)
- Junichiro Niwa  Professor at Tokyo Institute of Technology (Doctor of Engineering)
- Hideto Maki  Director of Road Technology Research Group at Public Works Research Institute
- Akisato Mizuno  President of Kogakuin University (Doctor of Engineering)
- Kenji Motohashi  Professor at Shibaura Institute of Technology (Doctor of Engineering)
- Nozomu Mori  Director of Road Department at National Institute for Land and Infrastructure Management

**Meeting**

First meeting (Dec. 4th) “Outline of Sasago tunnel and urgent inspection of tunnel ceiling panels”

- On-site inspection took place prior to the meeting.
  - Possibility of additional inspection in addition to ongoing emergency inspection was discussed
  - Additional examination including, pull-out test for the anchor bolt is necessary
  - Ceiling design at the construction phase needs to be reexamined

Second meeting (Dec. 21st) “Results of urgent inspection of outbound Sasago Tunnel ceiling panels and pull-out test for anchor bolt”

- Defects that were found in out-bound Sasago Tunnel were discussed
- Distribution of the defects found in out-bound Sasago Tunnel were reported
- An implementation plan of pull-out test was discussed
- Further tests, such as a compressive strength test for the core sample extracted from lining concrete, were considered
Recovery Work of In-bound Sasago Tunnel