Response Modification of Urban Infrastructure
都市施設の免震設計

第8章　橋梁に対する免震設計の適用
Chapter 8 Implementation of Seismic Isolation to Bridges

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Construction of Menshin bridges at the early days

初期の頃の免震橋の建設

東京湾横断道路浅瀬部橋梁

Tokyo Aqualine, Trans-Tokyo Bay Highway

最近の免震橋

Menshin bridges built recently

Takao Bridge
高尾橋

Expansion joint and deck end

Takao Bridge

高尾橋

Kouri Bridge

沖縄「古宇里大橋」

Kawanose Viaduct

高知県「河の瀬高架橋」

Ichinomiya Viaduct, 2nd Tomei Expressway

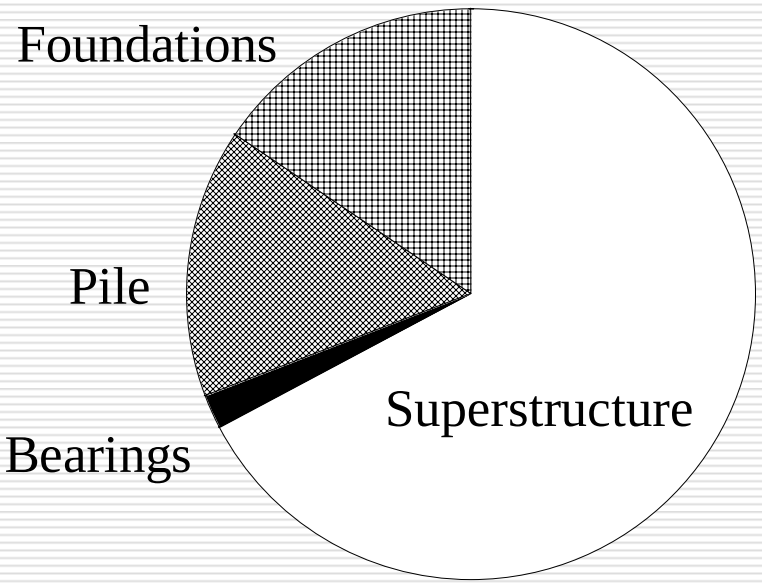
Kami-Hiroya Bridge, Keno Bipath, Kanto Regional Construction Office

Kinugawa Viaduct, Kita Kanto Expressway

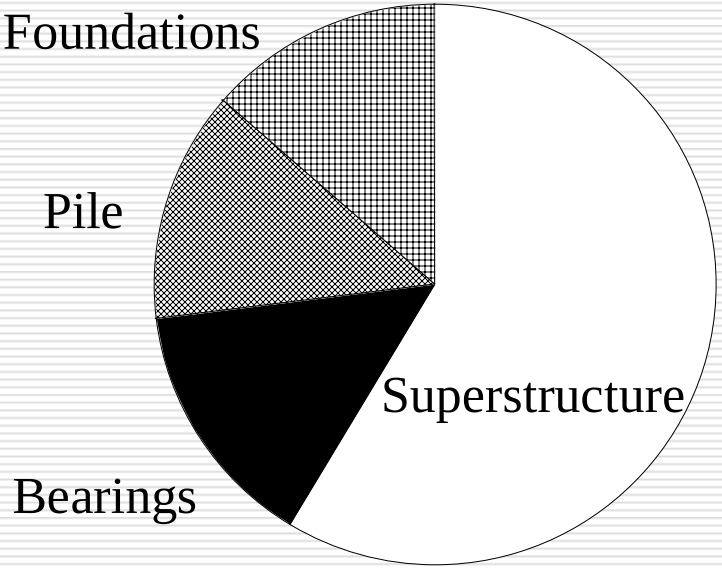
コスト縮減の試み

Cost Increase of Bearings after the 1995 Kobe EQ

Prior to Kobe

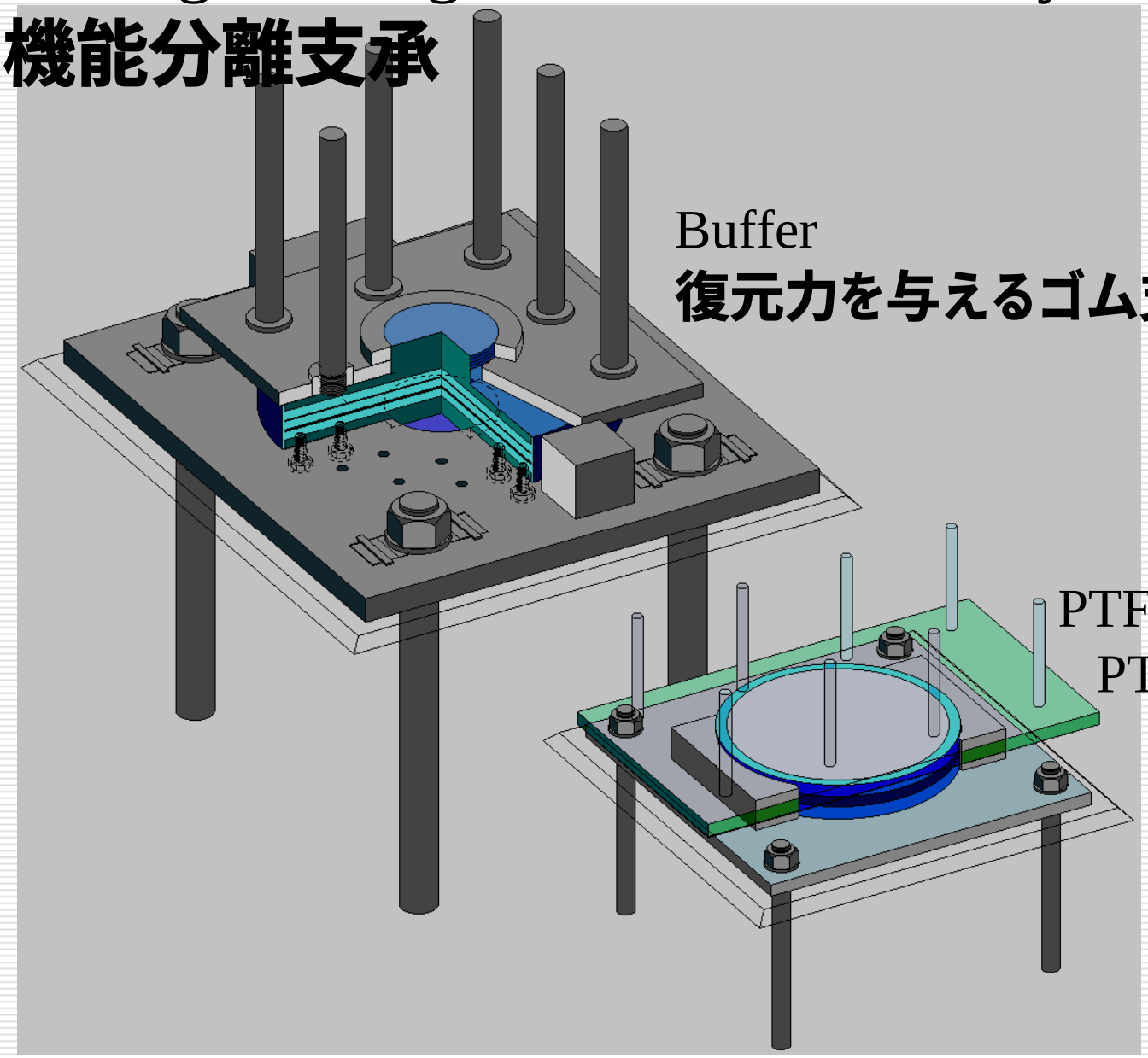


After Kobe



Sliding Bearing & Rubber Buffer System

機能分離支承

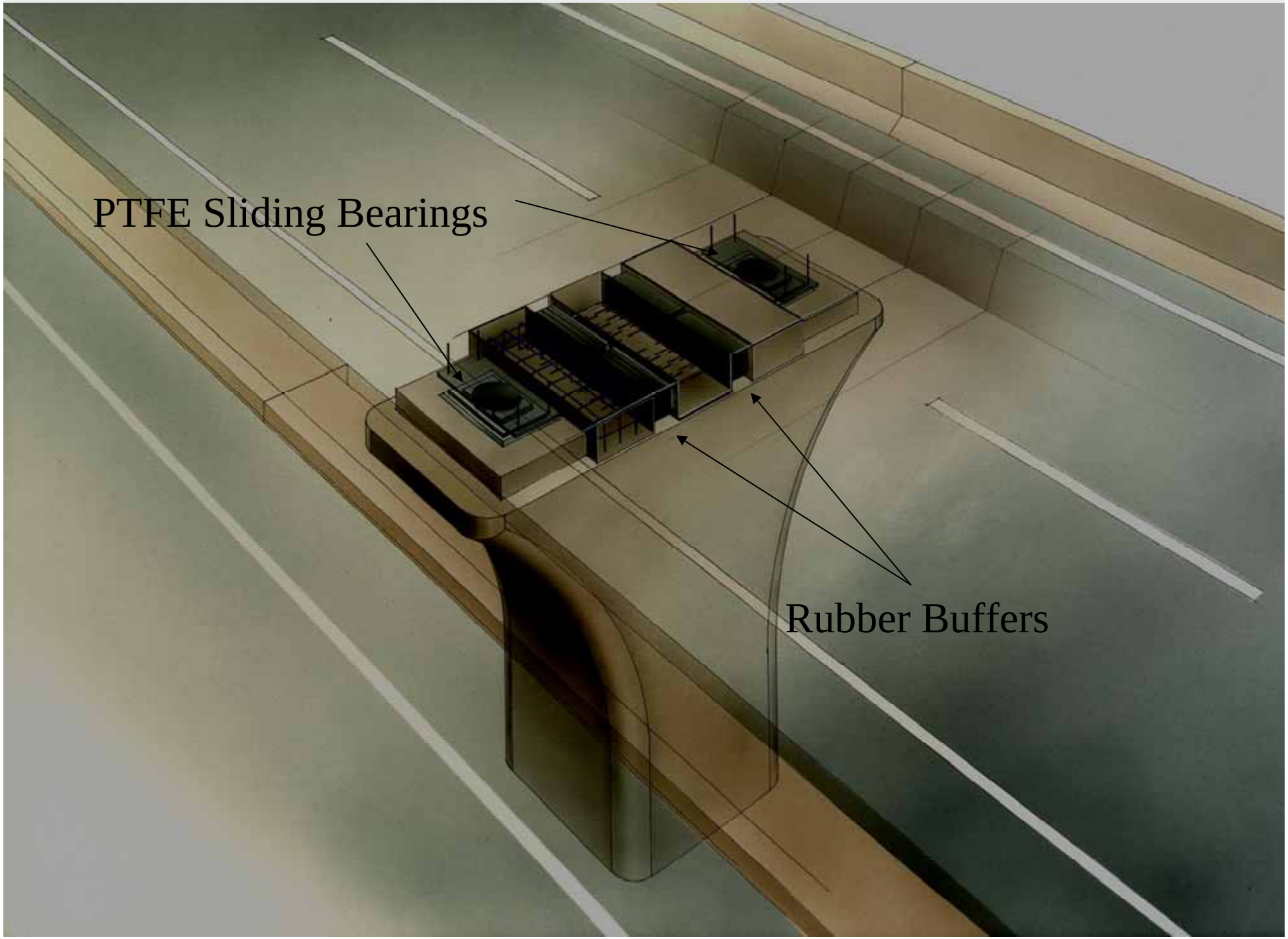


Buffer

復元力を与えるゴム支承

PTFE Bearing

PTFE**支承**


PTFE Sliding Bearings
Rubber Buffers

機能分離支承のメリットとデメリット

●メリット

✓ゴム支承は復元力を与えるためだけで、死荷重を支持しない。このため、ゴム支承のサイズを小さくでき、コスト縮減につながる

●デメリット

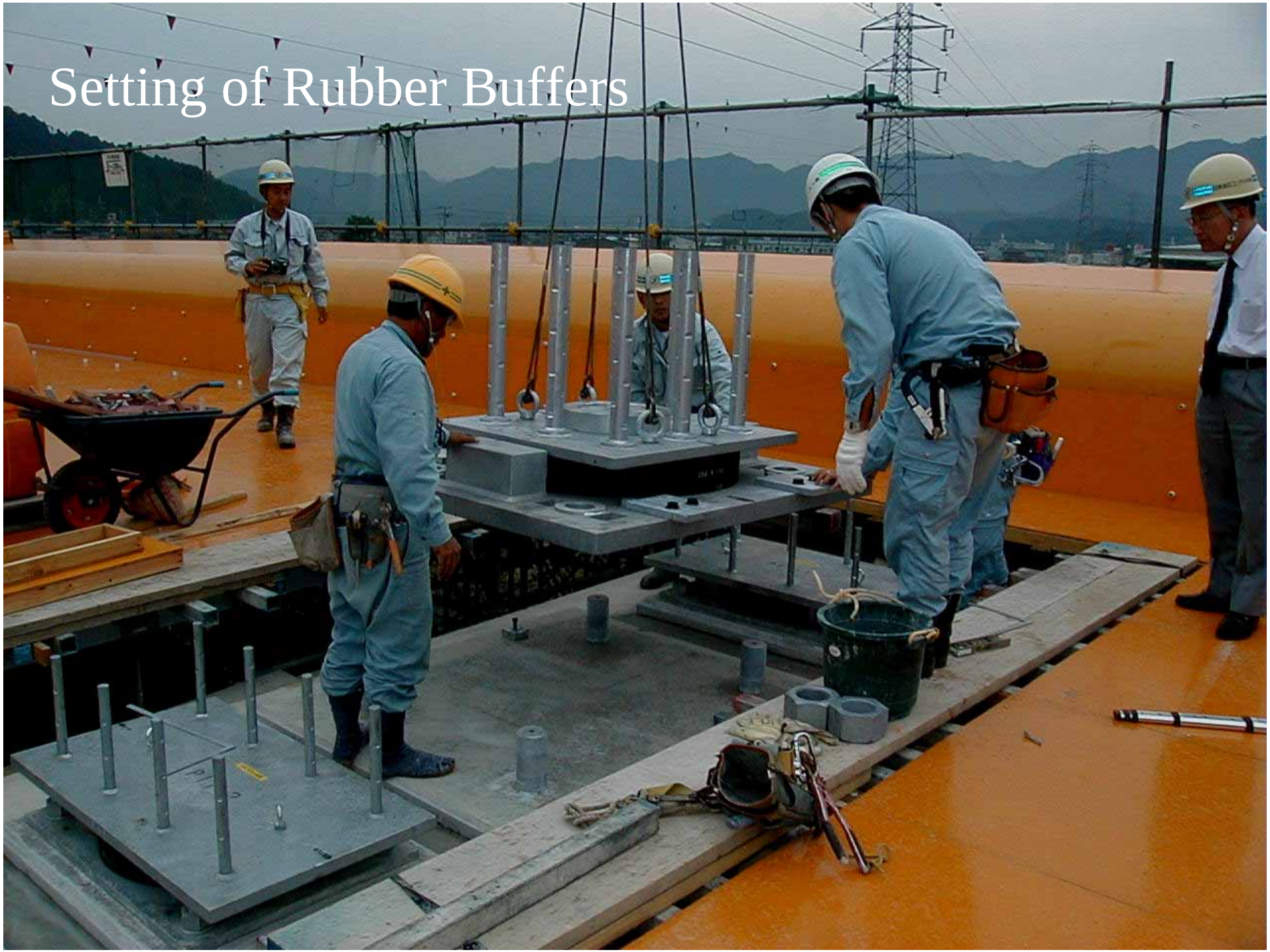
✓PTFE支承のサイズを超して桁の応答変位が生じると、上沓が下沓から逸脱するという、従来方式の被害が生じる

✓橋軸方向免震は可能でも、橋軸直角方向免震ができない。また、曲線橋や斜橋など複雑な橋の免震には要注意

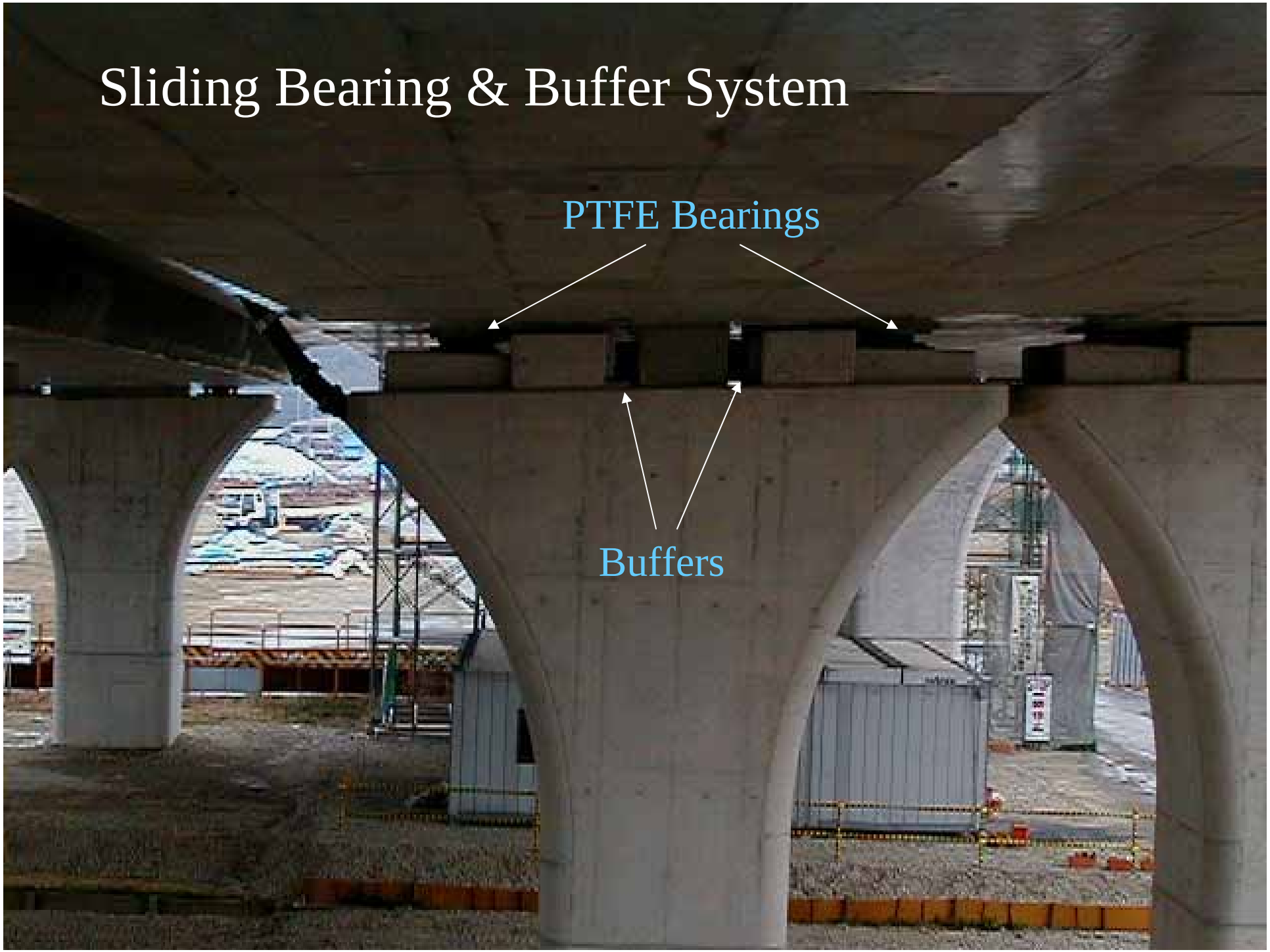
Viaduct Constructed using Sliding Bearing & Buffer System

Setting of PTFE Bearings

Setting of Rubber Buffers



Sliding Bearing & Buffer System



Seismic Restoration of Damaged Bridges using Seismic Isolation

免震設計を用いた震災復旧

Seismic Isolation Implemented for Reconstruction

Seismic Isolation Implemented for Reconstruction

Fukae Viaduct, Hanshin Expressway
1995 Hyogo-ken Nanbu EQ


Lead Rubber Bearings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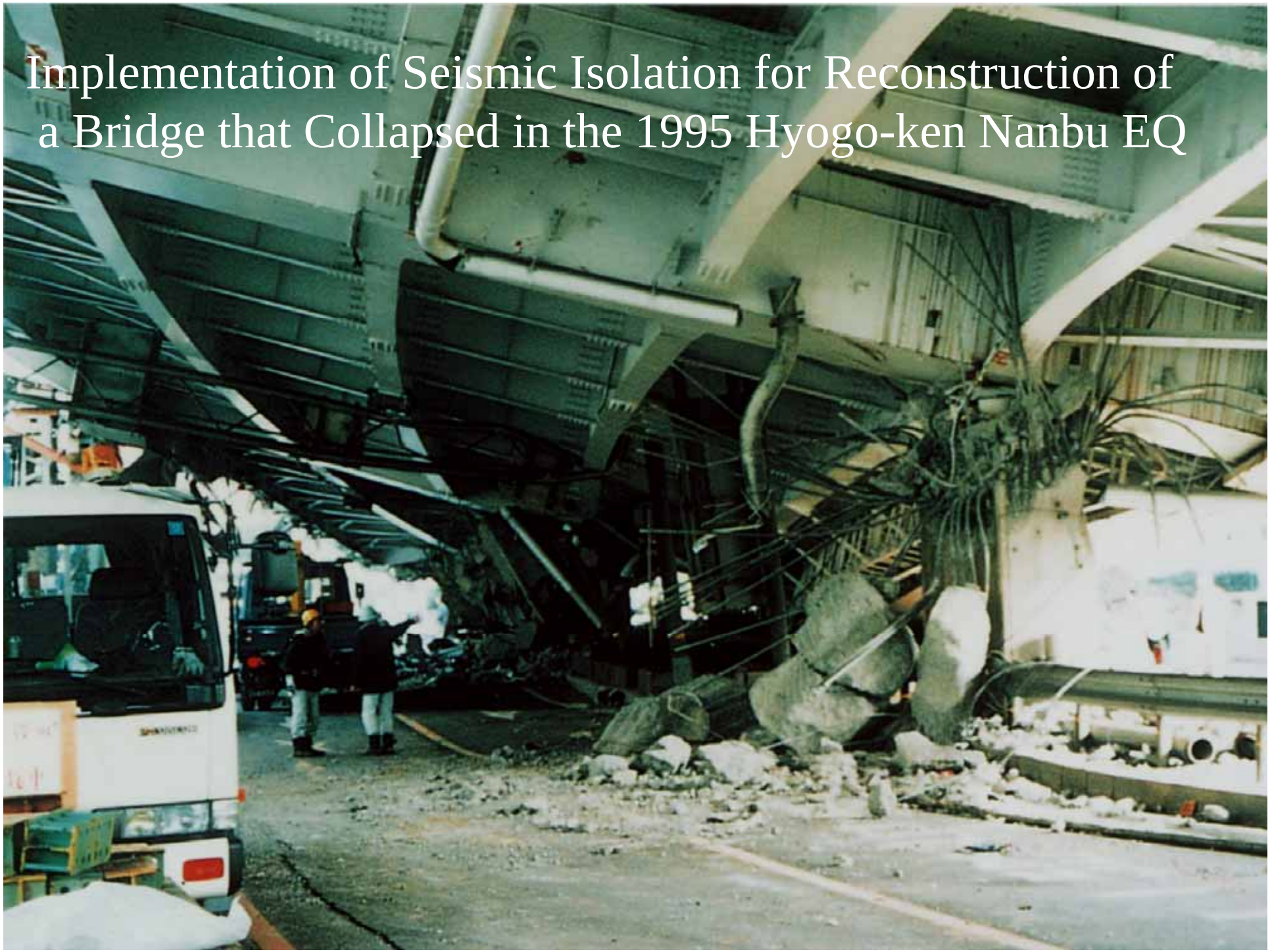
ピルツ橋の再建に免震設計が用いられた理由

●杭基礎は調査の結果、ほとんど被害を受けていなかった。復旧期間を少しでも短縮するために、既存の基礎を再利用する必要があった。

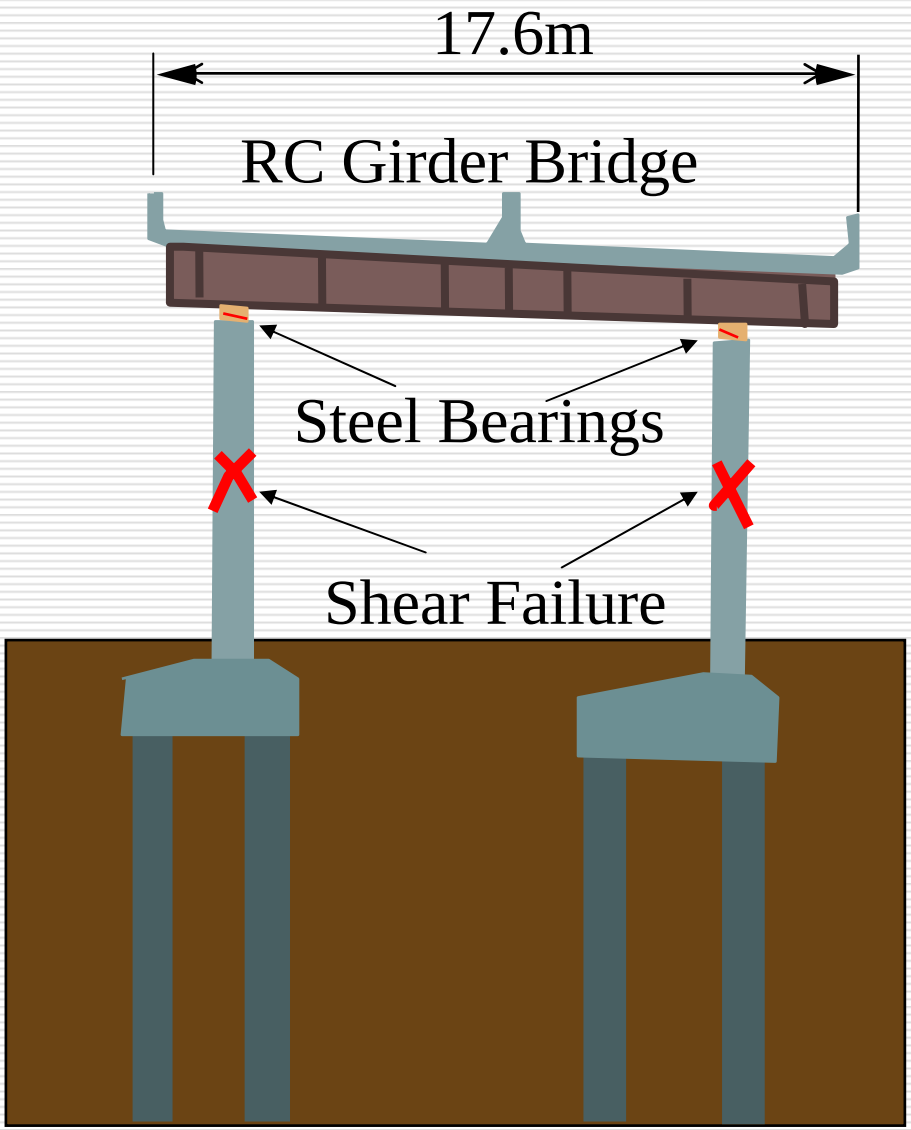
●このためには、上部構造からの慣性力を大幅に減少させる必要があった。

●桁構造をPCー＞鋼ボックス＋鋼床版桁に変更するとともに、免震が採用された

復旧後のピルツ橋

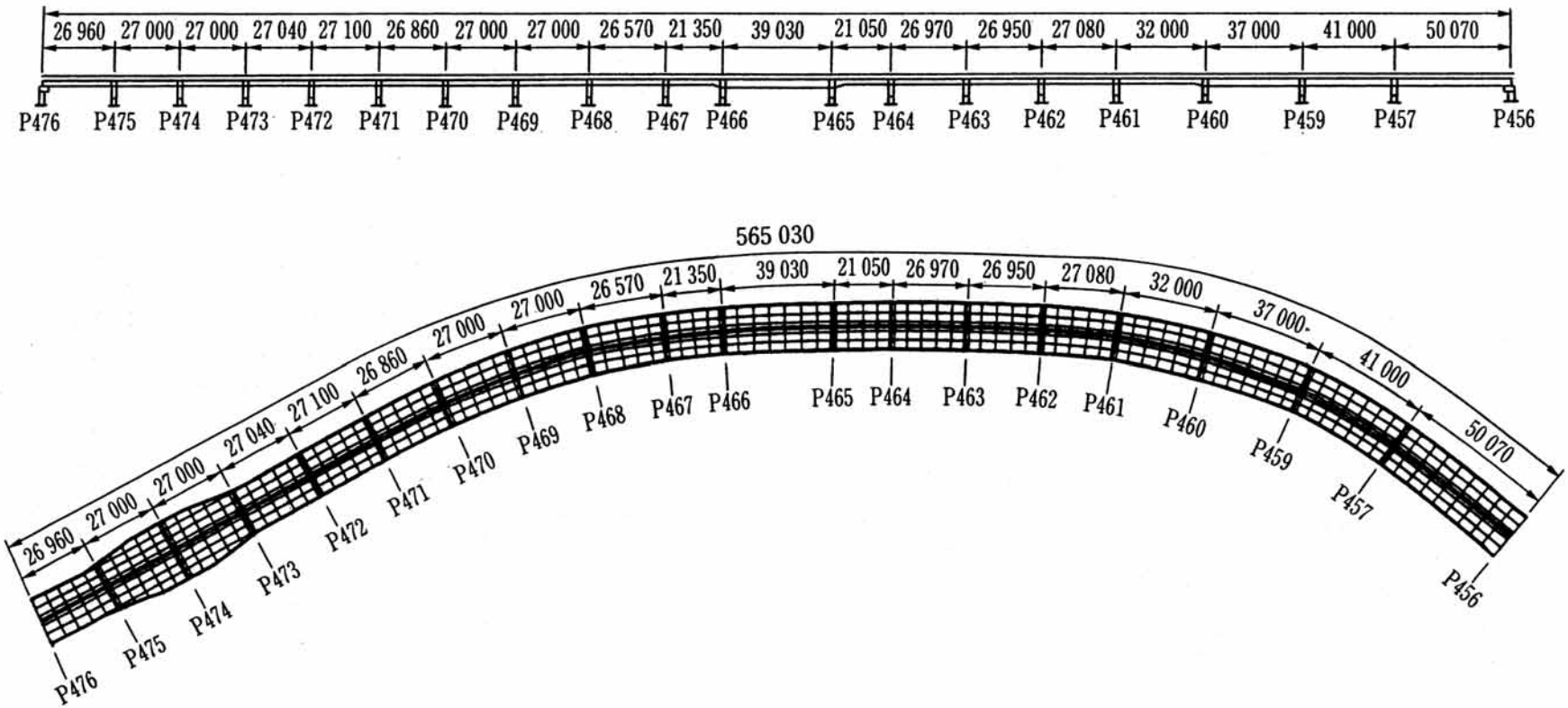

Implementation of Seismic Isolation for Reconstruction of
a Bridge that Collapsed in the 1995 Hyogo-ken Nanbu EQ

Damage Resulting from Failure of Piers & Bearings



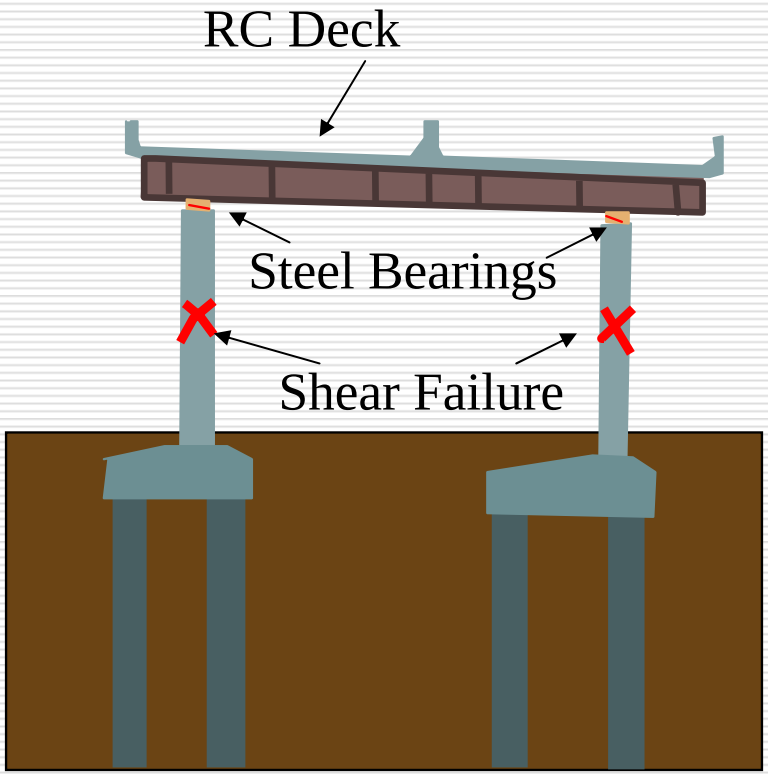
Reconstruction Strategy

- Since damage of foundations was minor, they should be re-used so that reconstruction period be minimized
- Reduce deck weight by replacing the existing concrete slab with a new steel deck
- Construct 20-span continuous bridge

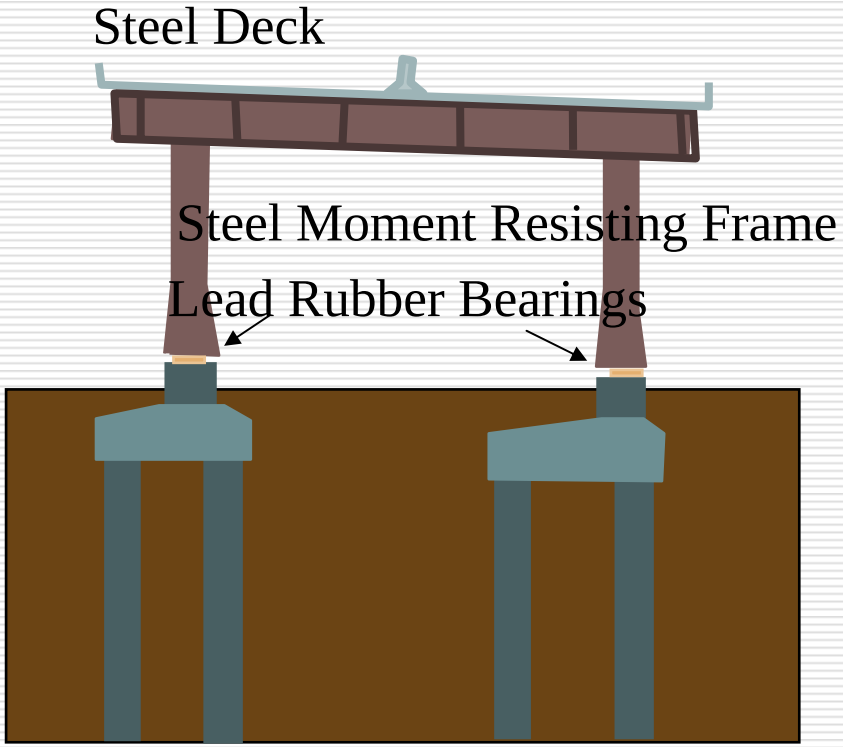


Reconstruction Using Lead Rubber Bearings

Original

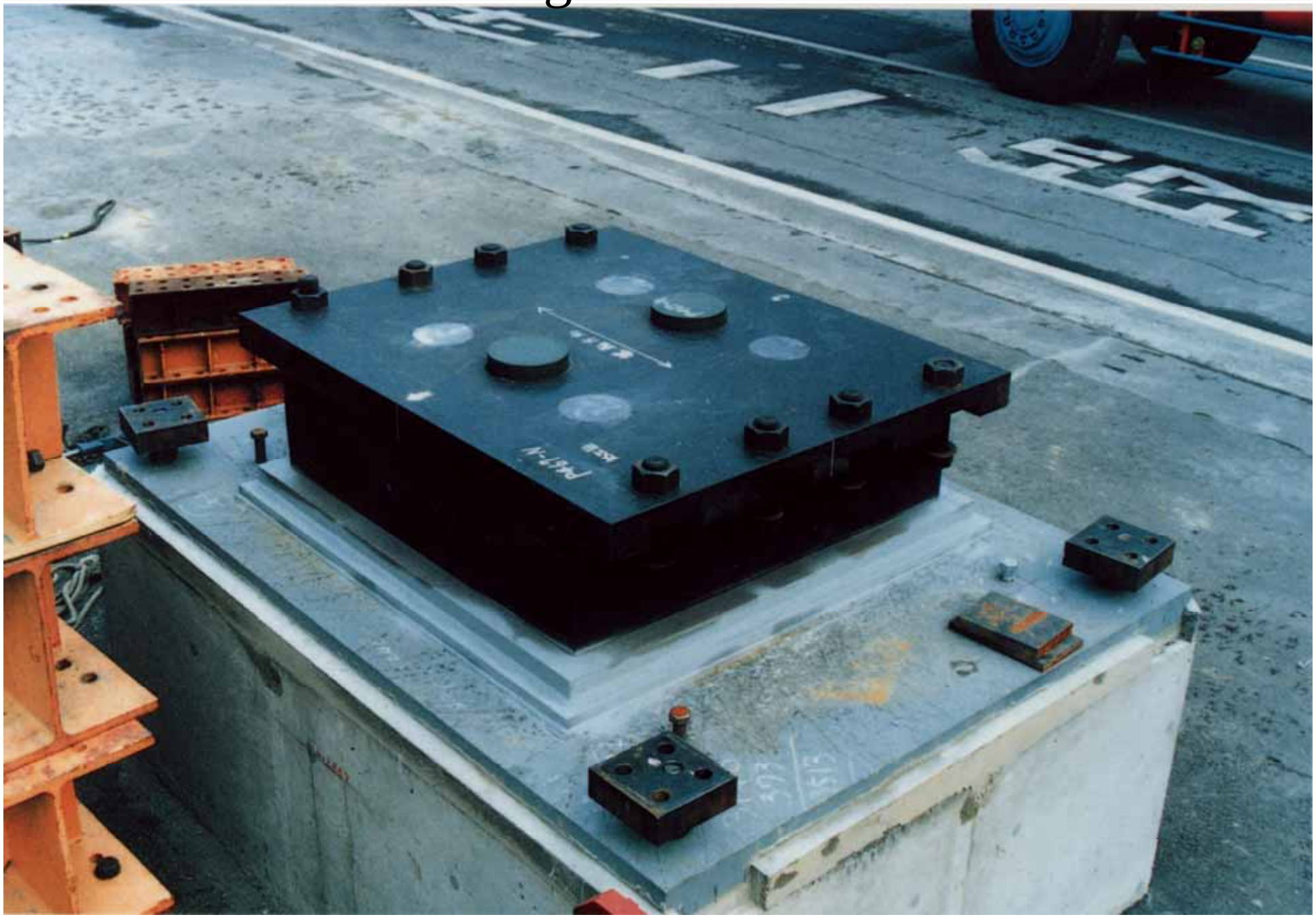


Reconstructed



Implementation of Seismic Isolation for Reconstruction

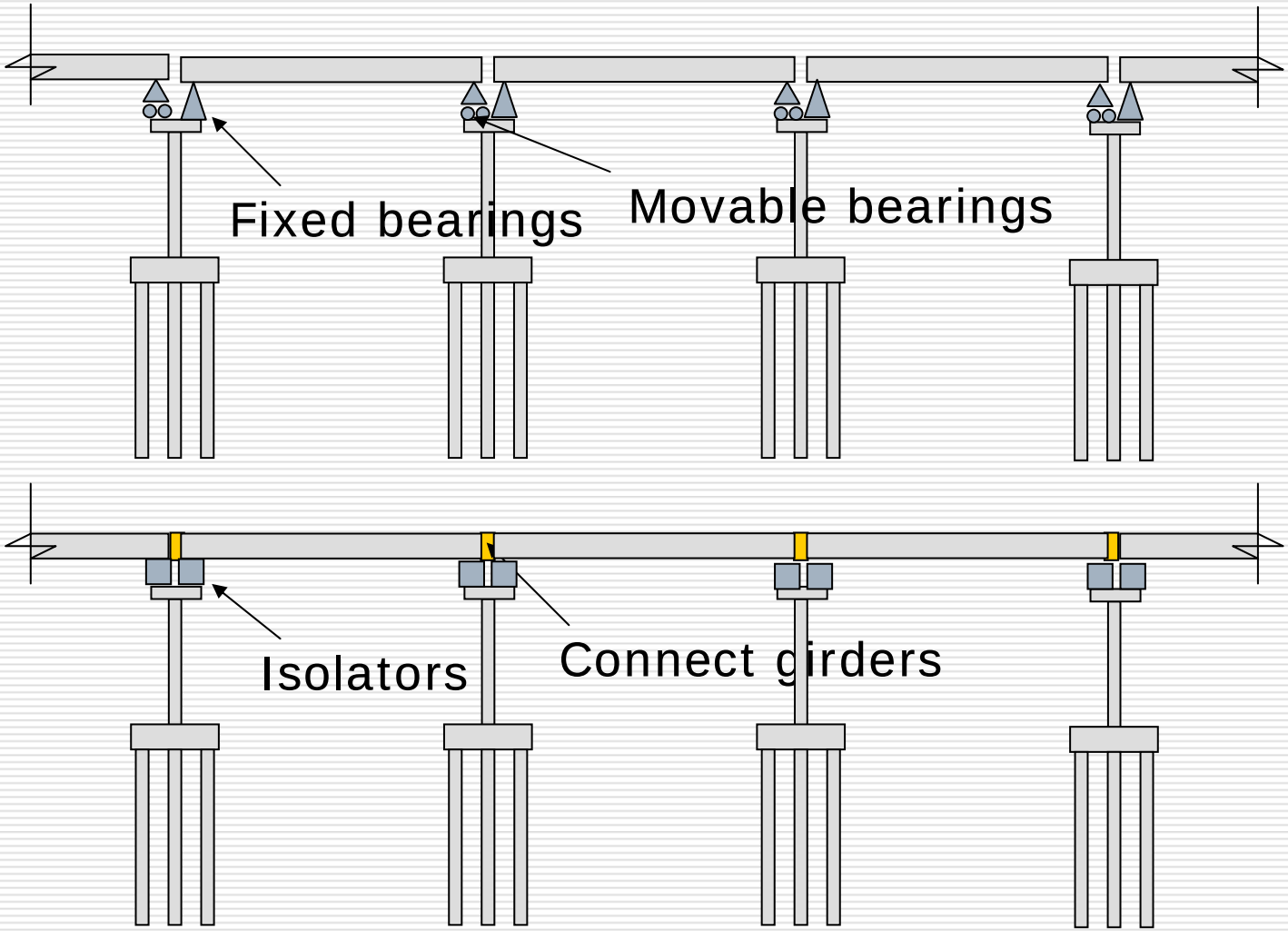
Lead Rubber Bearing Placed on a Pedestal



Reconstructed Benton Viaduct

Implementation of Seismic Isolation to Retrofit
免震設計を用いた耐震補強

Implementation of Seismic Isolation for changing the support condition from “Simply Supported Girders” to “a Continuous Girder”



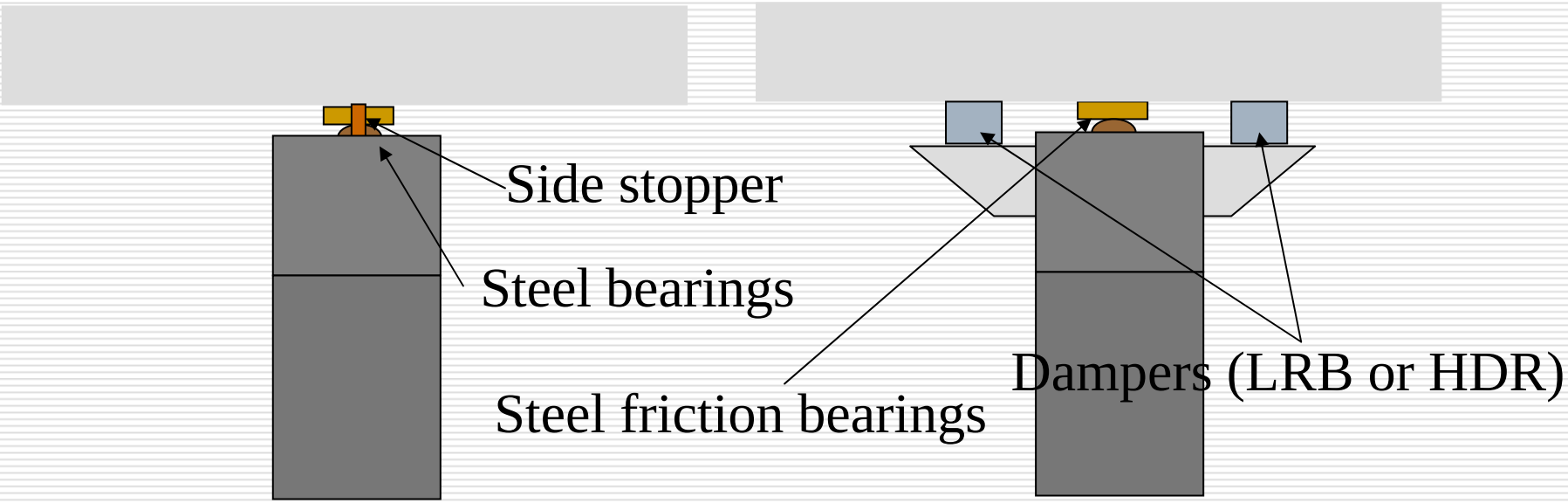
Implementation of Seismic Isolation for changing the support condition from “3 Simply Supported Girders” to “a 3-Span Continuous Girder”

Replacement of Existing Steel Bearings with LRBs

Seismic Retrofit using Seismic Isolation

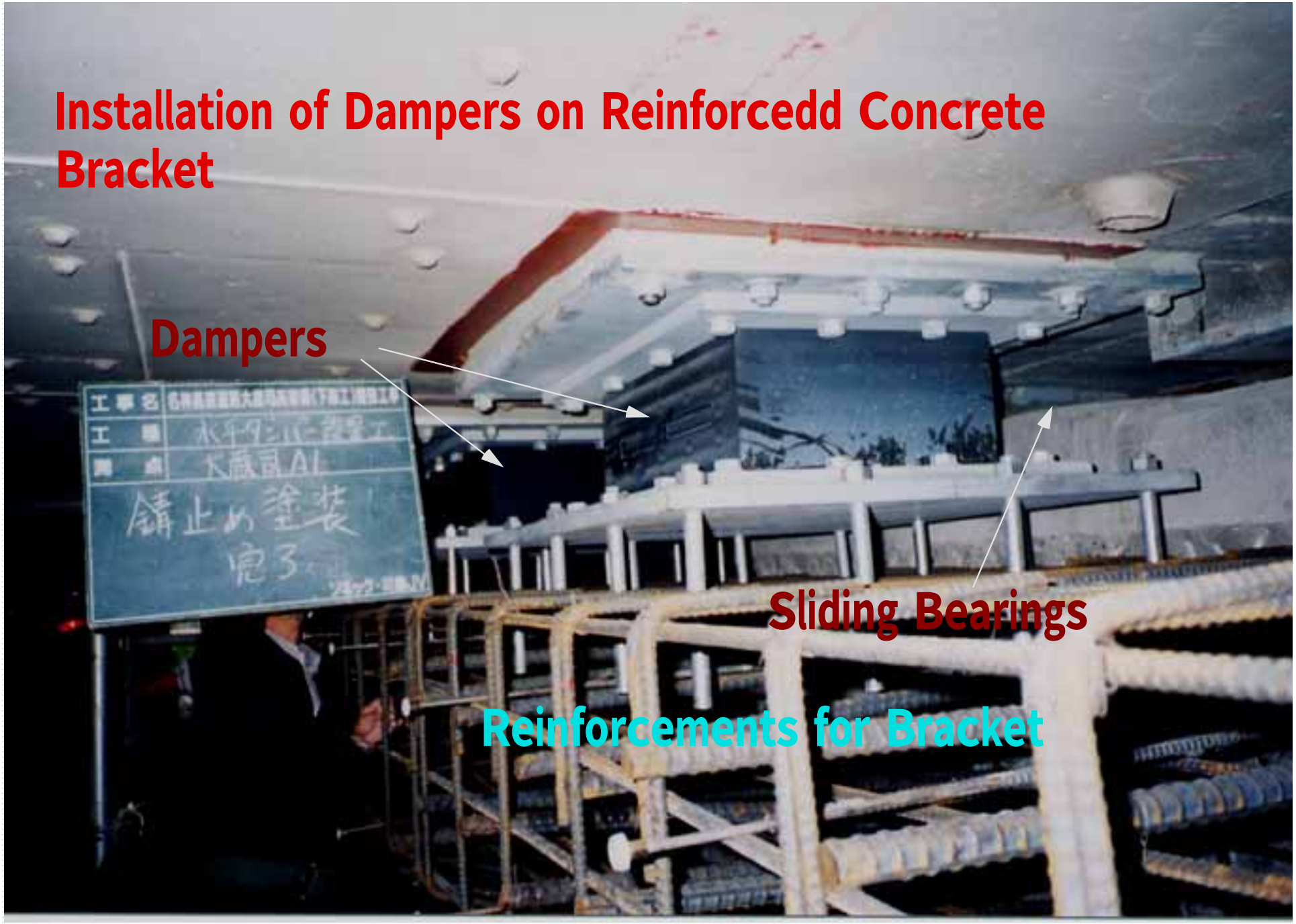
Existing

Retrofitted



Okura Bridge, Tomei Expressway

Installation of Dampers on Reinforcedd Concrete Bracket



After Retrofitted

Turukawa Bridge, Tomei Expressway