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Bridge Lock-up Device System

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BRIDGE LOCK-UP DEVICE SYSTEM

THE NEED

A series of severe earthquakes in the past few years has prompted transportation agencies throughout the U.S. to bring their bridges up to current seismic standards. The Colebrand Lock-up Device (LUD) provides additional substructure strength to resist seismic forces as a structural shock transmission unit for highway bridges. This system can provide a temporary rigid link between bridge structural members under seismic, braking, or other fast-acting type loads, while permitting slow thermal movements. It is applied between bridge girders or between a bridge pier and girder to permit load transfer. It provides an economical solution for new bridges and bridge retrofit applications.

FIGURE 1 LOCK-UP DEVICES CONFORM TO THE GRADUAL MOVEMENTS OF A BRIDGE BUT REMAIN RIGID DURING SEISMIC ACTIVITY.

THE TECHNOLOGY

The maintenance-free LUDS, manufactured by Colebrand, Ltd, London, provides a temporary rigid link between the deck and supporting abutments and piers of a bridge so that under fast-acting and short duration seismic, traction, braking or accidental forces, the load is shared between the supports. The devices work by means of a piston-

and -rod configuration housed inside a compound-filled noncorrosive cylinder. During slow movements such as thermal expansion or contraction, the liquefied compound gradually migrates from one side of the piston to the other, allowing the piston and cylinder to expand or contract with the structure. Under slow acting thermal, shrinkage or creep movements the Colebrand LUD no longer acts as a rigid link and moves with the deck. The LUD does not absorb energy. The unique property of the Colebrand LUD is that it can accommodate slow thermal movements whilst remaining instantly responsive to transmit and share shock loads with benefit between those elements. The LUD consists of an enclosed steel cylinder containing a loose-fitting piston fixed to a transmission rod. The cylinder is packed with a specially formulated Colebrand compound. The cylinder is filled with an unpressurized silicon-based compound that can flow around the piston to accommodate slow thermal movements. The key characteristic of the LUD is that, under the action of a sudden load from whatever source or axial direction such as an earthquake, no transfer of material takes place through the annular space. The compound does not adjust quickly to accommodate the movement, and it essentially locks up to stabilize the structure. The result is that the piston and cylinder are effectively locked together, thus providing a temporary fixed link.

FIGURE 2 COLEBRAND LUD OPERATING MECHANISM

FIGURE 3 COLEBRAND LUD'S ARE NORMALLY USED ON BRIDGES, HOWEVER THEY CAN BE INSTALLED ON ANY STRUCTURE THAT REQUIRES OR WILL BENEFIT FROM THE TRANSMISSION OF DYNAMIC/SHOCK LOADS

THE BENEFITS

The Colebrand LUD is simple to install, and provides a controlled rigid/flexible link between the superstructure (deck) and substructure (abutments, piers, columns, etc.) of a bridge. This allows fast acting, dynamic/shock loading (e.g. traction, braking, seismic, impact, wind) to be distributed or shared among the whole structure. Under slow acting dynamic loadings (e.g. thermal expansion/ contraction, shrinkage, creep) the Colebrand LUD remains passive and allows the structure to move.

- Cost-effective upgrading of existing structures
- Efficient design of new build construction via reduction in structural component sizes
- Simple installation with minimal, if any, traffic disruption
- Structural protection against braking/traction/seismic and other exceptional load conditions
- Cost savings : Colebrand LUDs provide a means of strengthening existing bridge sub-structures at far lower costs than by conventional methods. Further cost savings result from the operator's ability to keep the structure open during installation

STATUS

Four innovative lock-up devices (LUD) were installed on a bridge in southern Illinois on August 1999, making this demonstration site the first in the United States where Colebrand LUDs were used. This technology has been utilized in several places around the globe, yet not in the United States before this time. The three-span structure used for the LUD demonstration is a continuous steel girder near the New Madrid fault system in southern Illinois. Following list is the list of completed and in progress projects

- Mekong River Friendship Bridge (Thailand) - R.C. multi-span box girder
- Arthur Laing Vancouver (Canada) - R.C. road bridge multi-span
- Putney Bridge (UK) - Steel plate girder rail bridge
- Nabouwalu Road Bridge (Fiji) - R.C. road bridge
- Neath Bridge (UK) - R. Concrete Rail Bridge
- South Calder Viaduct (UK) - Traction/braking loads control retrofit
- Chicago Beach Development (UAE) - Steel plate girder with R.C. abutments Road Bridge
- Settle Rail Bridge (UK) - R.C. railbridge box girder, single span

Colebrand also announced their involvement in the Korean High Speed Railway contract, a construction between Seoul and Pusan, the capital and major seaport of Korea. This infrastructure project, being constructed for the Korean High Speed Rail Construction Authority, includes 526 Colebrand Lock-Up Devices of 1750kN and 900kN capacity. The units will give protection against the high braking and traction forces that will be experienced by the bridges during the operation of the High Speed trains. The New York State DOT has volunteered one of their projects to serve as a demonstration project. The project has started and will place several LUD's on multiple bridges.

BARRIERS

Colebrand LUD's are not intended for energy/shock absorption, but transmit load from one part of the structure to another.

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REVIEWERS

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