Seismic Evaluation of Grouted Splice Sleeve Connections for Reinforced Precast Concrete Bridge Piers

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Accelerated Bridge Construction

ABC Connections Modified for High-Seismic Regions

Utah Transit Authority (2012)

Khaleghi et al. (2012)
Air Tests

GGSS

FGSS
Air Tests

- Rebar fracture
- 169%fy on average
- Type 2 (Building)
- FMC (Bridge)
  
  **GGSS**
  
  \( fy = 76 \text{ ksi} \)

- Pull-out failure
- 145%fy on average
- Type 1 (Building)
- FMC (Bridge)
  
  **FGSS**
  
  \( \tau_1 \) (bond between rebar and grout)

\( \tau_2 \) (bond between grout and sleeve)
- Prototype bridges in Utah considered
- Capacity-based design procedure
- AASHTO LRFD and AASHTO Seismic for detailing
- Sectional and Pushover analyses conducted
Half-Scale Tests
Construction of Specimens
Half-Scale Tests/GGSS-1 Construction
Half-Scale Tests/GGSS-3 Construction
Half-Scale Tests/GGSS-CIP Construction
Half-Scale Test/FGSS-1 Construction
Half-Scale Test/FGSS-CIP Construction
Test Procedure
Test Procedure
Column-to-Footing Connections: Hysteretic Response

GGSS-1

GGSS-2

GGSS-3

GGSS-CIP

Test Results
Column-to-Footing Connections: Observations

Test Results/GGSS-2
Column-to-Footing Connections: Observations

@ 3% Drift

@ 6% Drift (Peak)

@ 8% Drift

Test Results/GGSS-3
Column-to-Footing Connections: Curvature Profile

GGSS-2

GGSS-3

Column-to-Footing Connections: Comparison

Test Results
Column-to-Cap Beam Connections: Hysteretic Response

FGSS-1

FGSS-2

FGSS-CIP

Test Results
Column-to-Cap Beam Connections: Observations

@ Peak 3% Drift

@ Peak 6% Drift

@ 6% Drift
Column-to-Cap Beam Connections: Observations

@ 3% Drift

Test Results/FGSS-2
Column-to-Cap Beam Connections: Curvature Profile

FGSS-1

Column-to-Cap Beam Connections: Comparison

FGSS-2

Test Results
Repairability

- CFRP composite doughnut with headed steel bars
Repairability

- CFRP composite doughnut with headed steel bars

Repaired specimen performed as good or better than the precast GSS specimen:

- 18% larger ultimate load capacity
- 18% larger ultimate displacement capacity
- 5% larger displacement ductility
- 15% larger energy dissipation capacity at 6% drift ratio
General Findings

- Desirable ductile performance of the CIP specimens
- Failure of CIP specimens was rebar fracture due to low cycle fatigue
- Localized damage for precast specimens with GSS in column base
- Similar damage state, strength capacity, curvature distribution, and hysteretic performance to CIP specimens when GSS located in footing or cap beam, BUT different termination point and displacement ductility capacity for all precast specimens
- Repairable ABC Connections

Column-to-Footing Connections [GGSS]

- Failure of all precast specimens due to premature rebar fracture
- Improved displacement ductility capacity when GGSS in the footing – harder to build
- Superior displacement ductility capacity when debonding implemented

Column-to-Cap Beam Connections [FGSS]

- Pull-out failure for FGSS-1 due to excessive bond-slip
- Pull-out failure and premature rebar fracture occurred for FGSS-2
- Improved overall performance when FGSS located in the cap beam – harder to build

Conclusions
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