A TRANSFORMATIVE INVESTMENT
IN CALIFORNIA’S FUTURE

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HIGH-SPEED RAIL: More Than A Transportation Program

• California is 7th Largest Economy in the World
• Comparable to Northeast Corridor in Terms of Distance, Population and Complexity
• Transformative Investment
• Connecting all California Population Centers
HIGH-SPEED RAIL OFFERS MORE CHOICES IN CALIFORNIA

• The State’s Population is Growing
  » 50 million by 2050

• Congestion Diminishes Our Competitiveness
  » Highway: Six of top 30 congested urban areas in US are in California
  » Airways: LAX to SFO is the busiest short-haul market in United States
  » Railways: Freight and passenger service share tracks

• Poor Air Quality Impacts Our Communities
  » South Coast and Central Valley Air Basins Don’t Meet Current Clean Air Objectives

• An Efficient and Less Expensive Alternative
  » Alternatives are 2-3 times more expensive
CONNECTING CALIFORNIA: PROJECT SCOPE

- **Phase I:**
  - 520 Miles
  - San Francisco to Los Angeles/Anaheim

- **Phase II:**
  - Extends 300 Miles
  - Connections to Sacramento & San Diego

- **Proposition 1A**
  - At least 200 mph
  - San Francisco-Los Angeles Union Station: two hours, 40 minutes
  - 24 total stations
PROGRAM DELIVERY STATUS

- Environmental Clearances
  - 10 sections, 2 completed
  - Complete Phase I by end of 2017
- Construction Underway (Design-Build)
  - Civil infrastructure in the Central Valley (Construction Package 1, 2-3 and 4)
- Requests for Expressions of Interest
  - Initial Operating Section (North and/or South)
  - Design-Build-Finance-Maintain
ENGINEERING CHALLENGES: MAJOR INVESTIGATION SEGMENTS

• Three segments for investigation.
  » Gilroy to Los Banos (Pacheco Pass)
  » Bakersfield to Palmdale
  » Palmdale to Burbank
SEISMIC SPECIALISTS TEAM

- Responsible for ground motion development for CP 1 and CP 2-3
SEISMIC SPECIALISTS TEAM

Fault Surface-Rupture Displacement

Kevin Coppersmith

Hazardous Fault Screening

Kevin Coppersmith

Fault Displacement Hazard Analysis

Bob Youngs, Kathryn Hanson (FW)
PRELIMINARY GROUND MOTIONS

• Process for developing Preliminary Ground Motions
  » Purpose: Develop ground motions at ground surface to be used during procurement process by CP bidders to develop bid proposal
  » Process:
    • Develop ground motions for MCE and OBE according to established procedures
    • Develop horizontal design spectra for $V_{S30}$ zones from PSHA using available site data and alignment data
    • Define controlling events using hazard deaggregation
    • Develop vertical design spectra from horizontal spectra
    • Produce time-histories matched to design spectra
    • Special sites such as those with structures over water crossings require site-specific exploration and are not included
Process for developing Final Ground Motions – Non-Special Sites

» Purpose: Develop ground motions at ground surface to be used during final design of elements such as aerial structures, bridges, tunnels, etc. for non-Special Sites (i.e., locations without highly nonlinear soils)

» Process:
  • Develop ground motions for MCE and OBE according to established procedures
  • Revise horizontal design spectra for $V_{S30}$ zones from PSHA using site data and alignment data acquired by CP Contractor
  • Define controlling events using hazard deaggregation
  • Develop vertical design spectra from horizontal spectra
  • Produce time-histories matched to design spectra
Special Sites

Locations where GMPEs cannot be confidently applied to develop vibratory ground motions at the ground surface

Such sites may include:

- Locations subject to liquefaction
- Locations subject to highly nonlinear soil response
- River crossings
- NEHRP Site Classes E and F
- Locations with complex structures (long span bridges, tunnels, underground structures, trench boxes, etc.)
• Process for developing Final Ground Motions – Special Sites

» Purpose: Develop ground motions at depth to be used during final design of elements located at Special Sites

» Process:

• Develop ground motions for MCE and OBE according to established procedures
• Develop spectra and spectrally matched ground motions for $V_{S30}$ of 520 m/s, 760 m/s and 1220 m/s from PSHA and deaggregation in advance of Special Site exploration
• CP Contractor to obtain $V_s$ measurements in 500 ft boring
• Develop horizontal design spectra at specified depth in profile
• Produce time-histories matched to design spectra
• CP contractor to perform site-response analysis to produce horizontal design ground motions and spectra at ground surface
• Develop vertical design spectra from horizontal spectra
Process for Fault Screening/Hazard Analysis

» Purpose: Determine whether faults that cross or are in close proximity to the alignment are hazardous and if so conduct a hazard analysis

» Process for Fault Screening:
  • Holocene displacement (i.e., movement within last 10,000 yr)
  • Slip-rate greater than 1 mm/year
  • Recurrence interval less than 1,000 yr

» Process for Hazard Analysis:
  • Conduct probabilistic displacement hazard analysis (PDHA) for MCE and OBE at fault crossings for hazardous faults passing fault screening
  • Determine displacement, fault orientation relative to alignment, width of fault zone and locations of displacement
Required hazard data

» Vibratory Ground Motion:
  - Validated probabilistic seismic hazard analysis (PSHA) code
  - Seismic source model (faults and distributed seismicity)
  - Ground motion prediction equations in terms of $V_{S30}$
  - Full logic tree to capture uncertainty
  - Deaggregated hazard to define controlling events
  - Used OpenSHA, UCERF2 source model and NGA-West1 GMPEs
  - Will update with UCERF3 and NGA-West2 GMPEs going forward

» Fault Surface-Rupture Displacement:
  - Validated Probabilistic Displacement Hazard Analysis (PDHA) code
  - Seismic source model (faults)
  - Fault displacement scaling relationships in terms of magnitude, type of fault, etc.
  - Full logic tree to capture uncertainty
  - Will use UCERF3 and currently available fault displacement scaling relations
SEISMIC DESIGN CRITERIA

• Discussion
THANK YOU

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