

# Seven Oaks Dam Intake Tower

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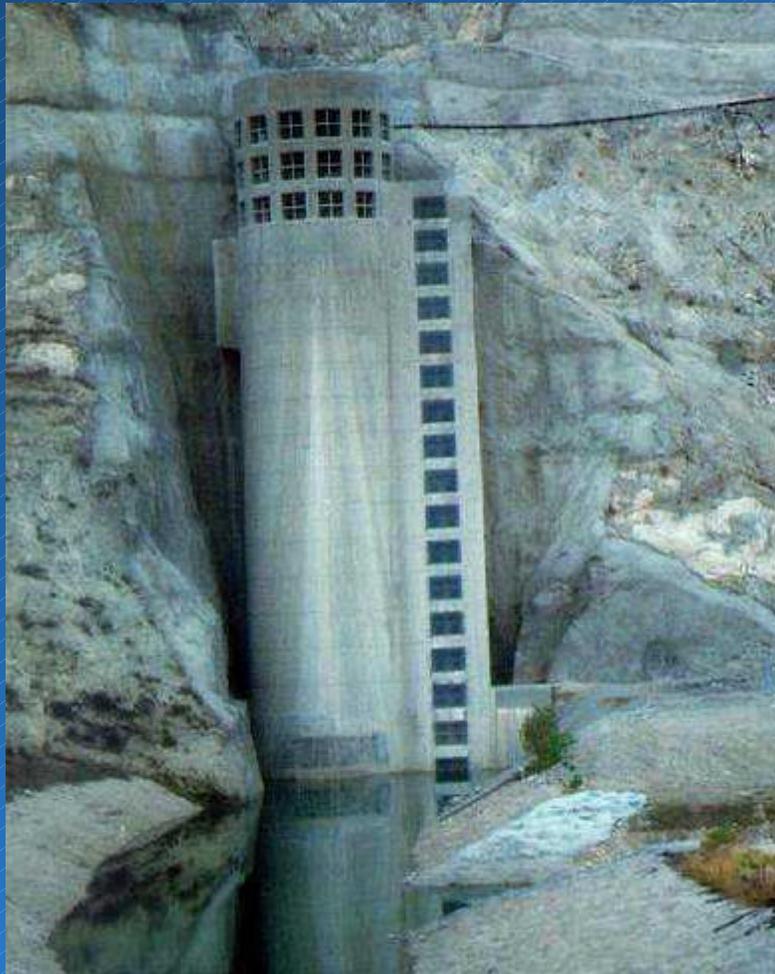
Seismic Rehabilitation of Hydraulic Infrastructure  
Workshop

Sacramento, CA, 13-16 Nov 2000

# Seven Oaks Dam Site Map



# Seven Oaks Dam Intake Tower



Local Sponsor: Orange County,  
San Bernardino County, &  
Riverside County

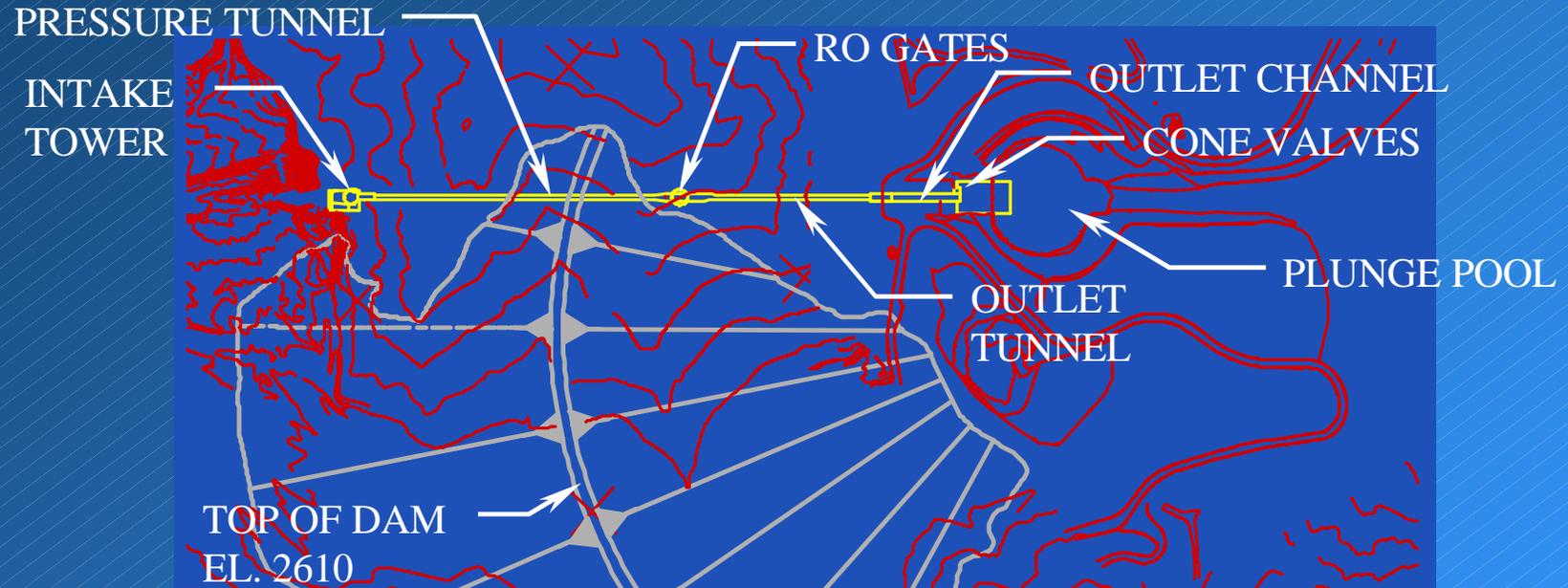
Project Design/Management:  
Los Angeles District

Tower Design: Portland District  
& Hydroelectric Design Center

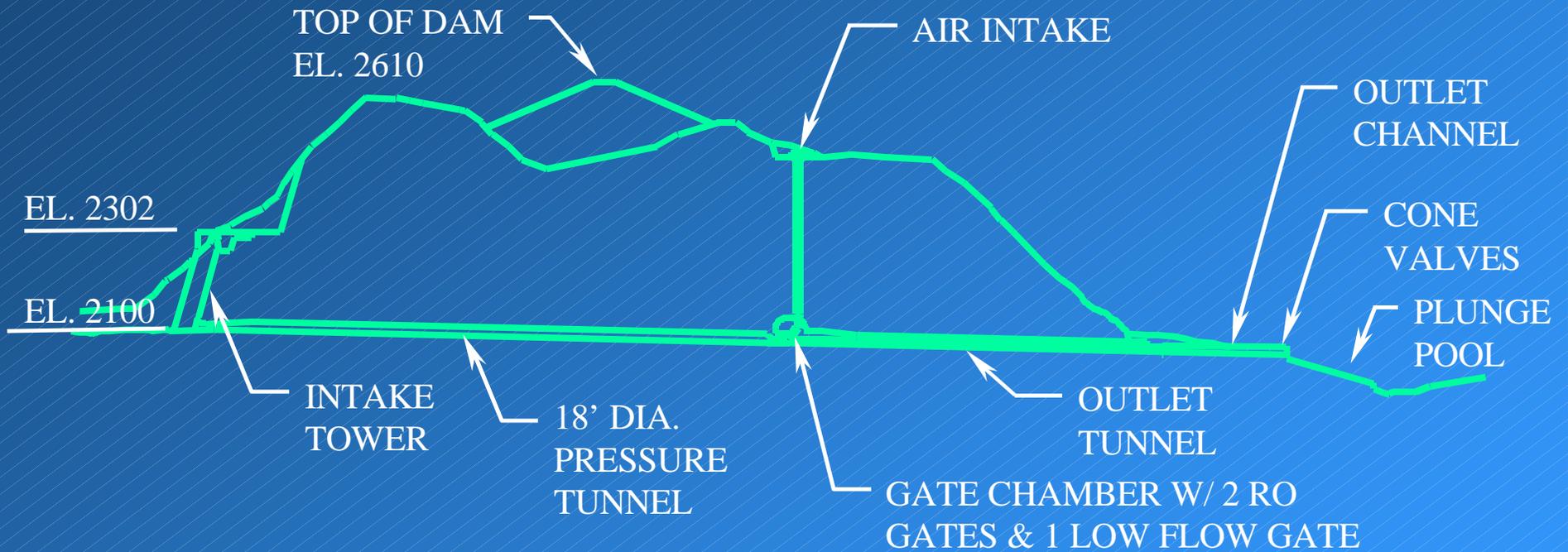
FE Modeling: Structures  
Laboratory, WES

Consultant: Dr. Yusof Ghanaat,  
Quest Structures

# Seven Oaks Dam



# Seven Oaks Dam



# Seven Oaks Dam

- Dam Height - 600 ft.
- Tower Height - 200 ft.
- U/S Tunnel - 18' dia., 1000' long
- D/S Tunnel - 18' X 18.5', 600' long
- Gate Chamber - 50' dia.
- Air Shaft - 11' dia., 320' vertical, max.  $v=140$  fps
- 2 RO Gates - 5' X 8.5'
- Max.  $Q=8000$  cfs, max.  $v=115$  fps @ RO gates

# Seven Oaks Dam



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# Seven Oaks Dam Design Criteria

- Normal debris pool (year 0) - El. 2150 (50')
- Normal debris pool (year 100) - El. 2300 (200') - sediment @ El. 2265
- 100-year flood - El. 2535 (435')
- SPF - El. 2575 (475')
- PMF - El. 2604 (504')
- Debris pool for 6 mos. & dry for 6 mos. (+/-)
- Controlling comb. - pool @ El. 2265 + EQ

# Seven Oaks Dam

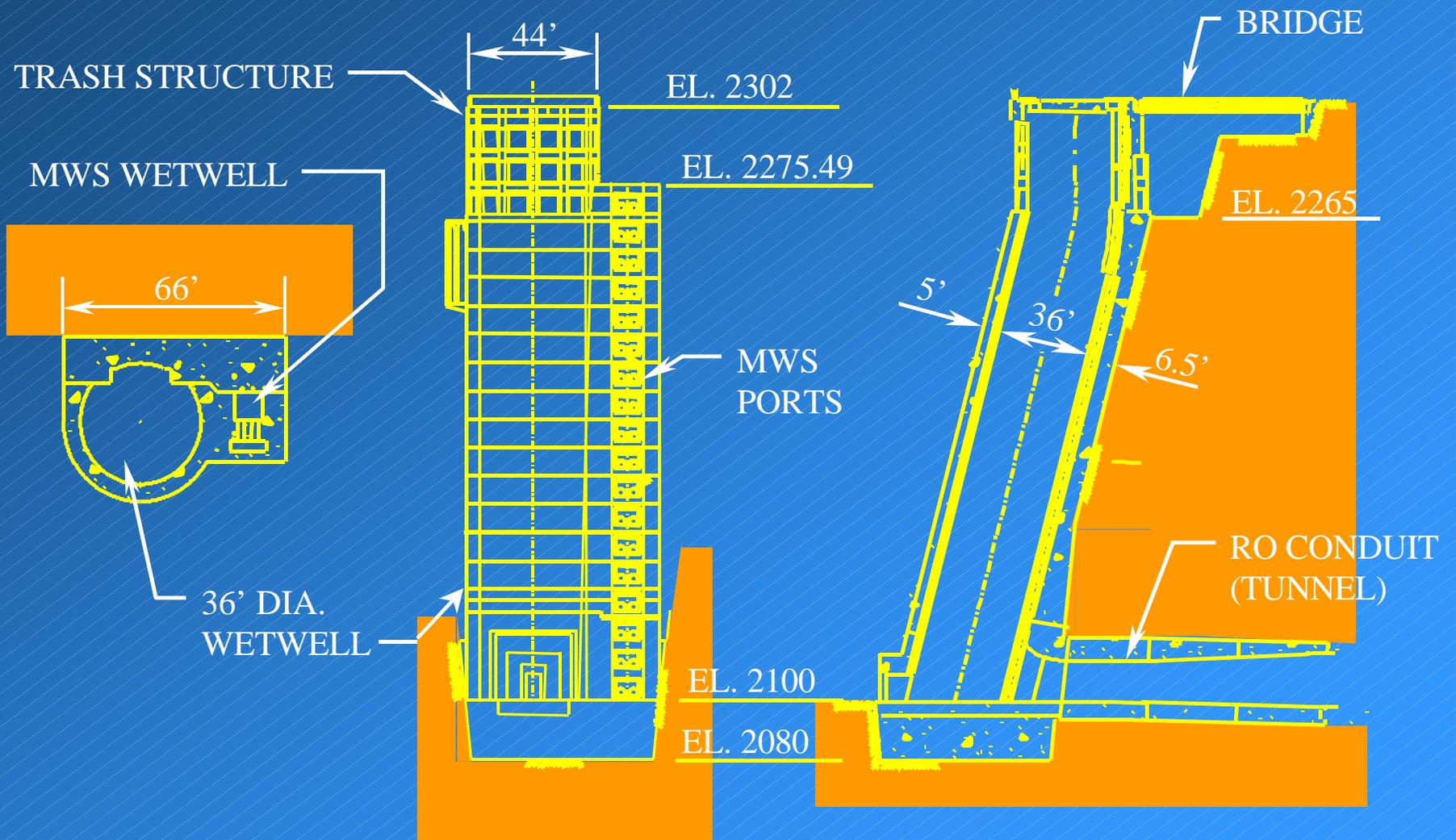
## Design Seismic Events

- MCE (magnitude 8+)
  - PGA - 0.7g
  - Recurrence rate - approximately 150 years
  - 1.2 miles away on branch of San Andreas Fault
- MPE (magnitude 7.5 - 8.0)
  - PGA - 0.5g
  - 1% chance per year (63% in 100 years)
  - 12 miles away
  - Considered same as OBE

# Seven Oaks Intake Tower Seismic Design Criteria

- MCE Performance Requirements
  - Inelastic, cracking, spalling, etc.
  - Maintain ability for controlled lowering of pool
- OBE (MPE) Performance Requirements
  - Fully operational
  - Damage does not require extensive repair
  - Elastic response
  - Controlled design ( $MCE/2 < OBE/1$ )

# Seven Oaks Intake Tower

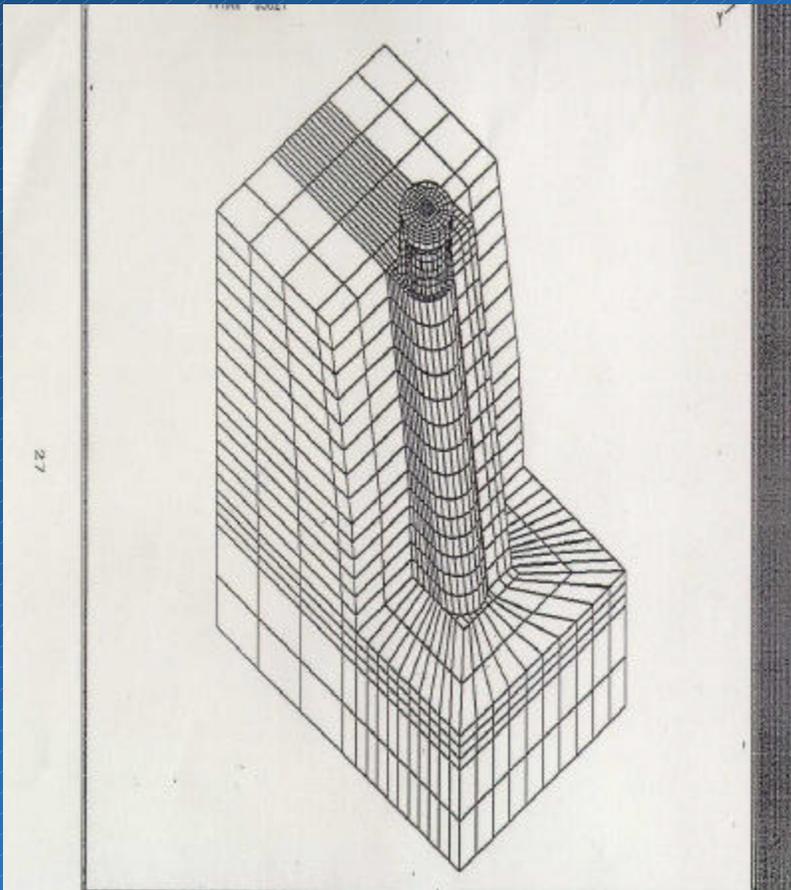


# Seven Oaks Intake Tower

## Types of Analysis

- Global
  - Response Spectrum (MCE and MPE)
  - Time History (MPE)
- Local
  - Response Spectrum (MPE)
  - Horizontal slices through structure
  - Trash Structure

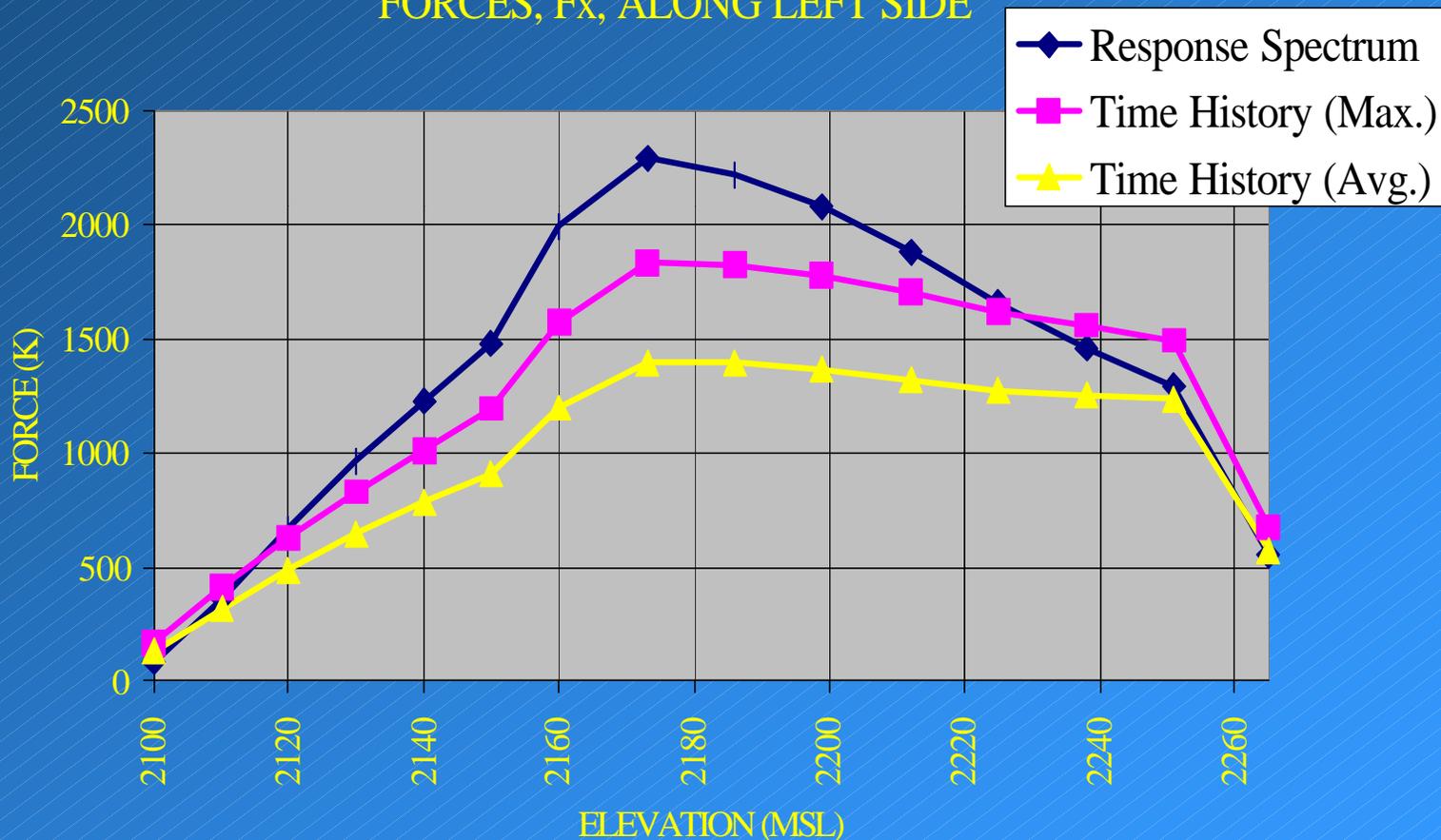
# Seven Oaks Intake Tower Global Analysis



- WES (Cray computer)
- 2545 Brick Elements, 190 Beam Elements
- 15,585 DOF
- Time History & Response Spectrum
- Added Masses (surrounding pool)

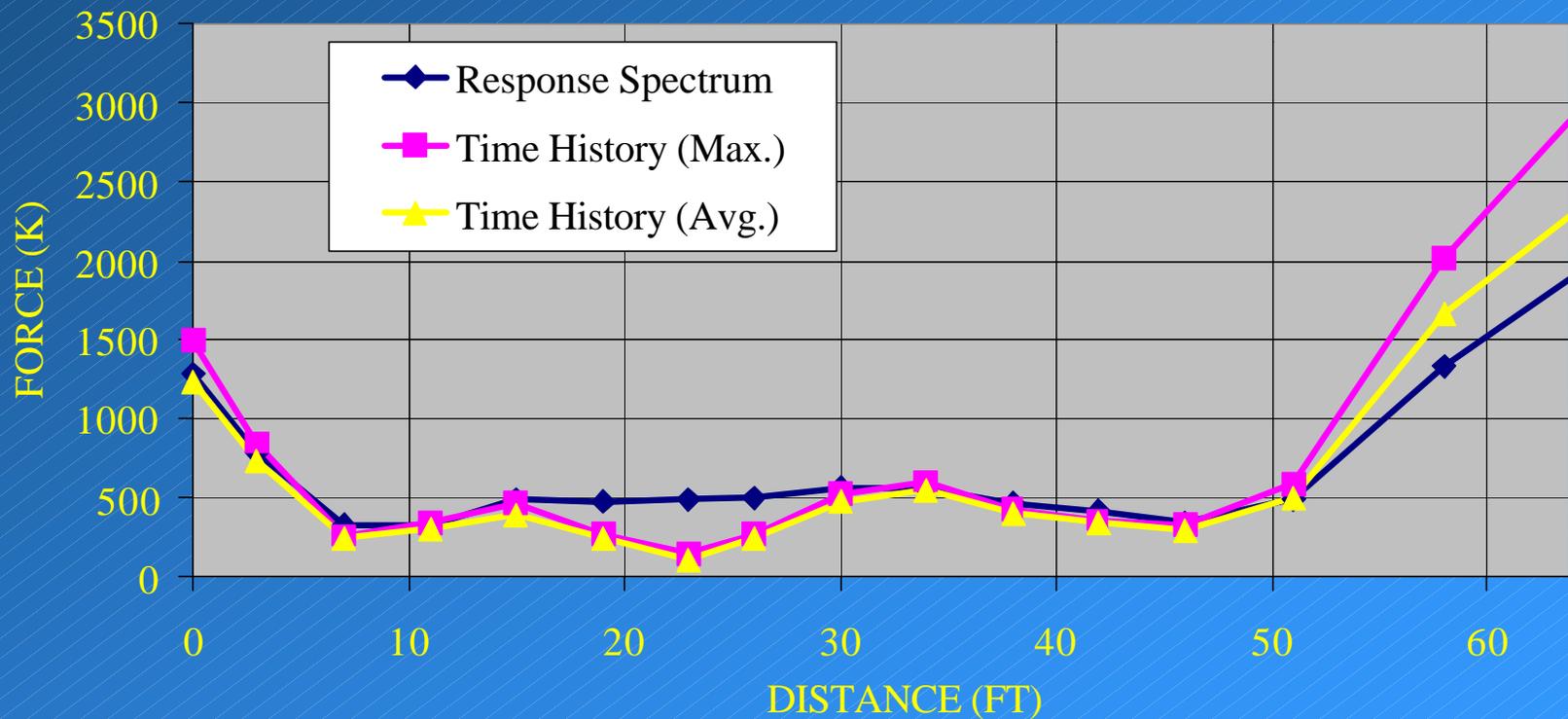
# Seven Oaks Intake Tower Global Analysis

FORCES,  $F_x$ , ALONG LEFT SIDE



# Seven Oaks Intake Tower Global Analysis

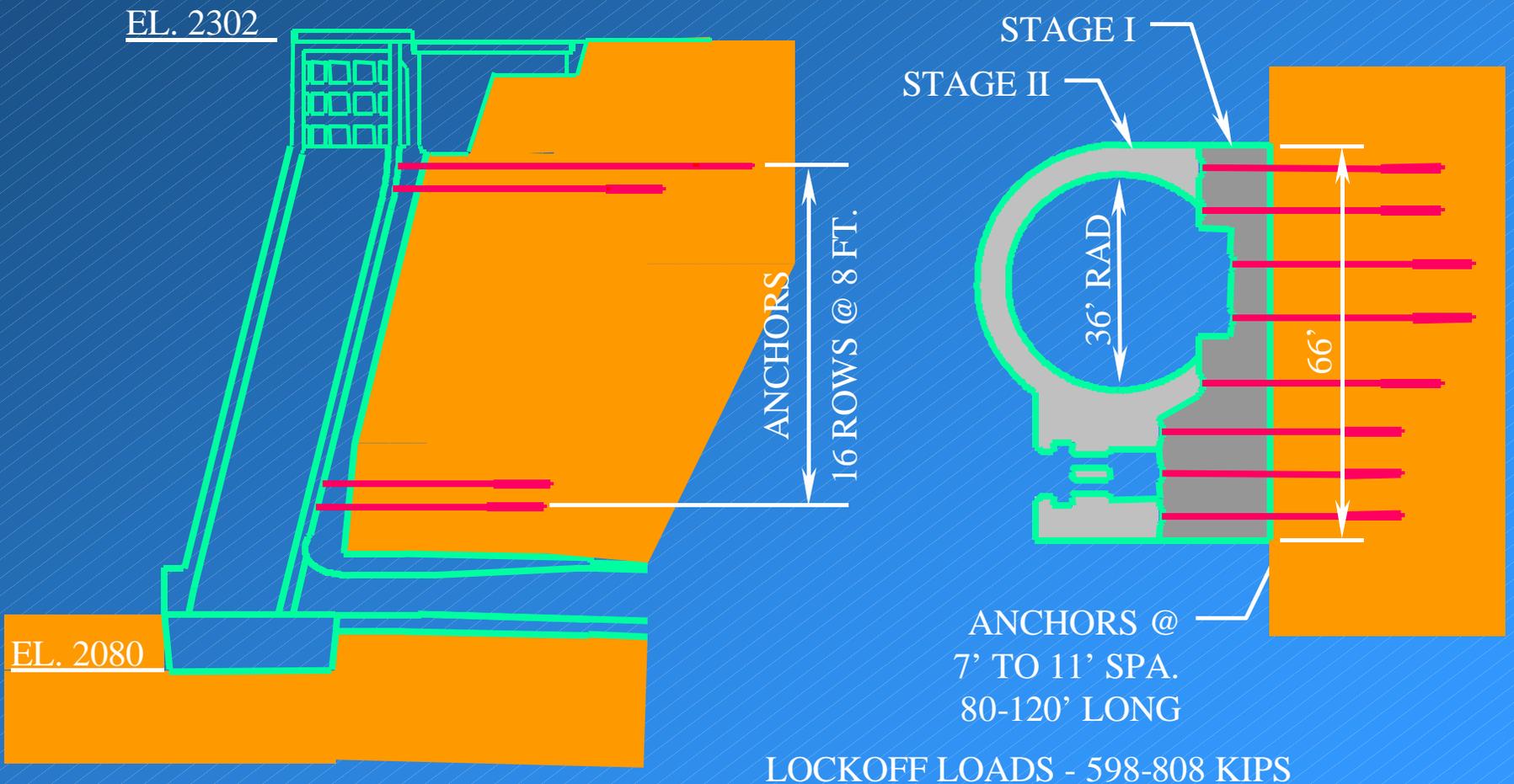
FORCES, FX, EL. 2251.96



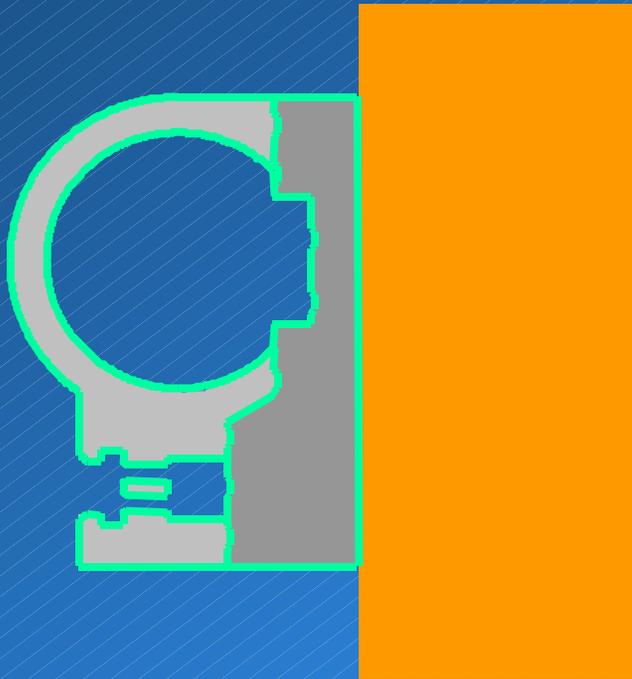
# Seven Oaks Intake Tower Anchorage System Design

- Results from 3-D response spectrum analysis by WES
- Forces at concrete-rock interface
- Summed forces on tributary area of anchor
- Anchor stressed to maximum force anticipated during OBE

# Seven Oaks Intake Tower Anchorage System

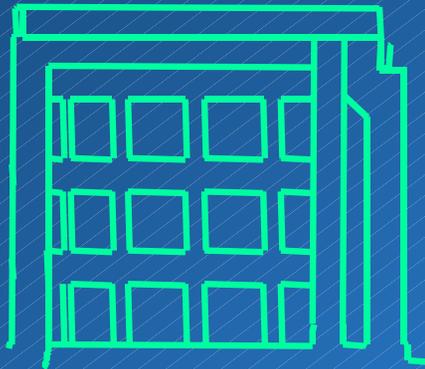


# Seven Oaks Intake Tower Tower Section Design



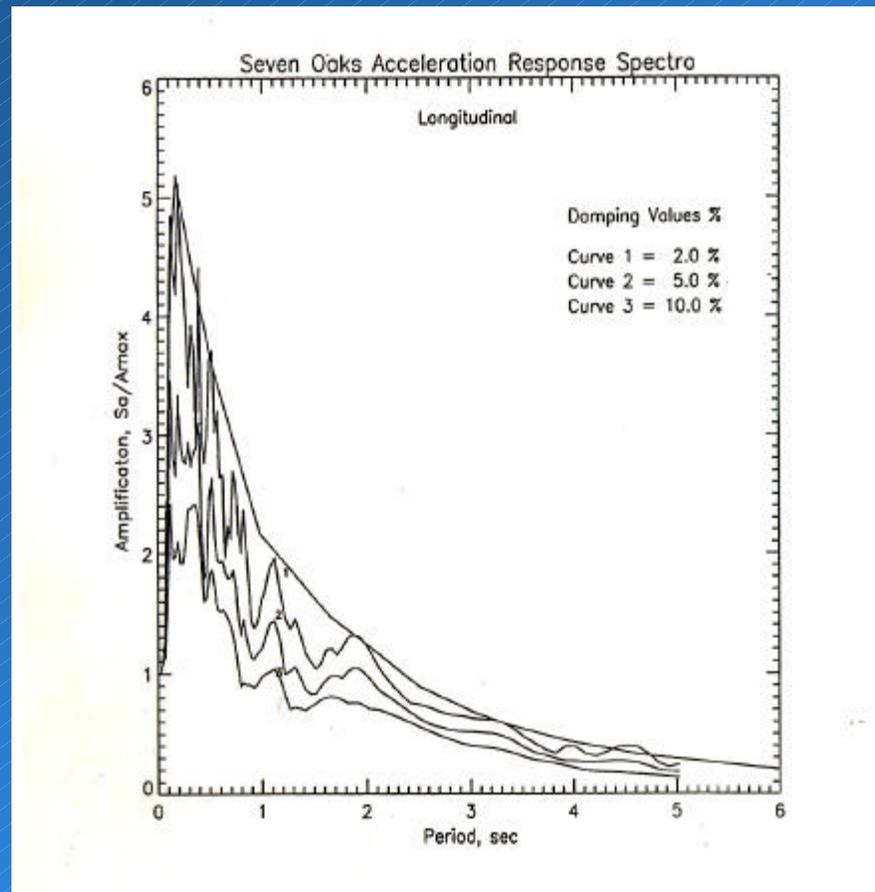
- FEM
- Response Spectrum
- Rebar Couplers  
between Phase I & II

# Seven Oaks Intake Tower Trash Structure

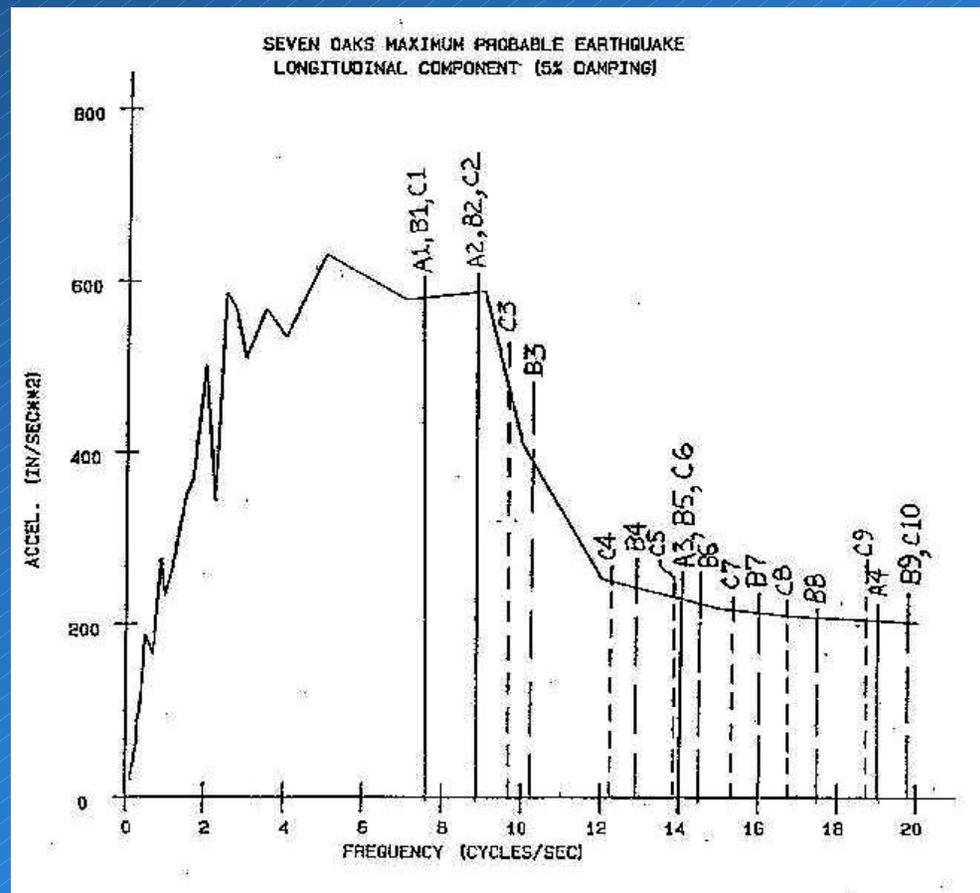


- FEM & Beam Elements
- Response Spectrum

# Seven Oaks Intake Tower Response Spectra



# Seven Oaks Intake Tower Response Spectra



# Seven Oaks Intake Tower Response Spectra

