Rock Slope Improvement Project: Kinematic Analysis, Construction Challenges, and Value Engineering Proposals

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ROCK SLIDE
SAN FRANCISCO
Public Property

Private Property
Note: Locations shown are approximate. Engineer to lay out precise rock anchor locations in the field.
Proposal Issues
• Overall Costs
• Available Funds
• Alternative Needed
Nearly 21,000 SQ FT of mesh
ROCK ANCHOR AT GROUND SURFACE DETAIL

SCALE: N.T.S.

- Spider Mesh
- Rock Anchor Beveled Washer and Hex Nut
- Mesh Spike Plate and Hex Nut
- Paint All Exposed Bar With Epoxy Coating
- Min. 12"x12"x1" Galvanized A36 Steel Anchor Plate
- TECCO Mesh

(E) Ground Surface
## ROCK ANCHOR SCHEDULE

(12 Wire Mesh Support Anchors, 115 Rock Anchors)

<table>
<thead>
<tr>
<th>Rock Anchor No.</th>
<th>Approximate Elevation (ft)</th>
<th>Dip Angle from Horizontal (°)</th>
<th>Orientation</th>
<th>Min. Unbonded Length (ft)</th>
<th>Min. Bonded Length (ft)</th>
<th>Test Load (kips)</th>
<th>Lock-Off Load (kips)</th>
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• GSI Analysis
• Same Conditions
• Same Back Analysis
• Required 16 kips
• Report states 32 kips
• Contract document reports 50 kip load
Uncoated Corrosion Resistant Steel Bar

- Soil Nails
- Tie-backs & Tie-downs
- Micropiles
- Rock Anchors
- Guy Anchors
- Wind Turbine Foundation Bolts
- Marine Bulkhead Wall Tie-Rods

Stages of Corrosion Damage Over Time

MMFX steel extends the operational service life and need for repair beyond 100 years by delaying corrosion initiation with a higher chloride threshold and slowing propagation due to a lower corrosion rate, making MMFX steel the most economical for all applications.
Post-Tensioned Rock Anchors

• **Industry Accepted Facts**
  - Increases resisting forces
  - Decrease driving forces
  - Use peak strength for design

• **Disadvantages**
  - More Expensive
    - Longer installation time
  - Loss of tension in bar
  - Potentially worsens weak and fractured rock
Rock Dowels (passive elements)

• Industry Accepted Facts
  – Increases resisting forces
  – Use residual strength for design

• Comparisons
  – Less Expensive
    • Single Installation process
  – Can be used in highly fractured and weak rocks
  – Plates and nuts are unnecessary
Results of Value Engineering

• No disagreement with analysis
• Length of time for re-permitting hindered acceptance
• Had to remain with permitted design
• Forced reduction in area of remediation to account for cost differences
Approximately 70 CY
Conclusions

- Proposals for original design were over budget
- Value engineering can be a fiscal and adequate (or improved) alternative
- Project Scope had to be reduced to stay within budget
- Field conditions can warrant fiscally responsible design changes
Thank you

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