PHX Sky Train – Taxiway ‘S’ & ‘T’ Undercrossings

Taking Trains Under Planes

David A. Burrows, P.E., Gannett Fleming, Inc.
Taking Trains Over Planes
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PHX Sky Train – Taxiway ‘S’ & ‘T’ Undercrossings
PHX Sky Train – Taxiway ‘R’ Bridge

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Acknowledgements

City of Phoenix Aviation Department

GF Structural Design Team:

- Mark Pilwallis (PM)
- Steve Sherrill (Design Lead)
- John Lobo (Structural Engineer)

- Assistance from various other Gannett offices and other design firms:
  Kimley Horn, Nabar Stanley Brown, Hatch Mott MacDonald, and Premier Engineering

McCarthy Kiewit Joint Venture (CMAR Contractor)
PHX Sky Train – Taxiway ‘R’ Bridge

1. Project Location and Introduction
2. Design Constraints
3. Load Pattern
4. Design Optimization
5. Construction
Project Location

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

TAXIWAY “T”  TAXIWAY “S”
• Stage 1 CM-at-Risk Construction Cost = $644M
• Stage 1A CM-at-Risk Construction Cost = $240M
STAGE 1A GUIDEWAY ALIGNMENT
Design Constraints

1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope
Unexpected Conflicts in Stage 1

Unknown conduit bank not identified in record drawings directly interfering with pile cap placement.
Unexpected Conflicts in Stage 1

Water Line per Plan

Actual Water Line Location
Unexpected Conflict in Stage 1A

Small electrical line turns out to be major power ductbank for T3

Pier 2 Location per IFC Plan

Pier 2 Location After relocation for ductbank and abandoned drilled shaft
Design Constraints

1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope
Design Constraints – Construction Schedule

- Unforeseeable utility conflicts in Stage 1 cost several weeks of construction time to resolve.
- Short window for construction – 6 months outside peak travel times of Thanksgiving and Christmas.
- Different approach taken for new abutment to mitigate utility conflict and schedule risk.

- Approx. 1,300 aircraft daily.
- 42 gates south of Sky Harbor Blvd.
- 64 gates north of Sky Harbor Blvd.
Innovative south abutment uses drilled shafts and shotcrete wall restrained at the top of backwall to minimize excavation and shorten schedule.
Design Constraints – Construction Schedule

- Airport operations could only allow one taxiway to be taken out of service at a time.

- Close proximity to Sky Harbor Blvd. required some night-time work for high traffic construction.

- Schedule reduced (shutdown duration) by using soffit fill construction method rather than falsework.
Design Constraints

1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope
Design Constraints – Existing Taxiway Bridges

Group V
Design Constraints

1. Utilities
2. Construction Schedule
3. Existing Taxiway Bridges
4. Guideway Alignment / Clearance Envelope
Design Constraints – Guideway Alignment / Clearance Envelope

• Max. guideway slope is 6.0%.

• Little distance between the edge of Taxiway T and Terminal 3 Station.

• Results in vehicle clearance envelope being too close to the bridge soffit. Solution: haunch the superstructure.
Load Pattern

- Load based on Boeing 747 configuration, with a maximum gross weight of 1,500kips.
- 92% of load carried by rear landing gear.
Load Pattern

- Per ACI 343, all girders between outside landing gear, if monolithic with slab, may be considered equally effective in resisting aircraft load.

- With Boeing 747 configuration, 7 girders resist rear landing gear load.

- Since aircraft can move laterally across entire bridge width, design each girder to take 1/7 rear landing gear load.
Design Optimization

30% DESIGN

- Eliminate transition slab
- Tie beam not required
- Retaining wall not required
- Eliminate new bridge pier

FINAL DESIGN

- Construct abutment for new span on existing footing
Design Optimization
MAY 2012: DEMO EXISTING TAXIWAY ‘S’

TAXIWAY ‘S’ SHUT DOWN ON MAY 22, 2012
DEADLINE TO RE-OPEN WAS NOVEMBER 19, 2012
MAY 2012: DEMO EXISTING TAXIWAY ‘S’
MAY 2012: EXCAVATE ADJACENT TO EXISTING ABUTMENT
MAY 2012: PREP. EXISTING ABUTMENT SURFACE
JUNE 2012: INSTALL ABUT. 1 DRILLED SHAFTS, ABUT. 2 REBAR
JUNE 2012: INSTALL ABUT. 1 DRILLED SHAFTS
JUNE 2012: INSTALL ABUT. 1 DRILLED SHAFTS
JULY 2012: CONTINUED WORK ON ABUT. 1, BACKFILL ABUT. 2
AUG. 2012: WORK ON ABUT. 1 BACKWALL, BACKFILL FOR SOFFIT
AUG. 2012: WASTE SLAB CAST AGAINST SOFFIT FILL
SEPT. 2012: FORMING BOTTOM SLAB AND WEBS
Monolithic Deck Pour

Bottom Slab & Webs

Bottom Slab & Webs

Bottom Slab & Webs

SEPT. 2012: POUR SEQUENCING
SEPT. 2012: FORMING BOTTOM SLAB AND WEBS
SEPT. 2012: POURING BOTTOM SLAB AND WEBS
Construction

SEPT. 2012: MONOLITHIC DECK POUR
Construction

SEPT. 2012: MONOLITHIC DECK POUR
OCT. 2012: POST-TENSIONING
OCT. 2012: SUPERSTRUCTURE DONE, WORK ON ANCHOR SLAB
Construction

NOV. 14, 2012, TAXIWAY RE-OPENED – 5 DAYS AHEAD OF SCHEDULE
ORIGINAL CONSTRUCTION ESTIMATE = $9.85M
FINAL CONSTRUCTION COST = $8.73M