PRECAST CONCRETE PAVEMENT FOR AIRPORTS

SWIFT 2017 - Chris Olidis, P.Eng.

With grateful acknowledgement to Shiraz Tayabji

APPLIED RESEARCH ASSOCIATES, INC.
An Employee Owned Company

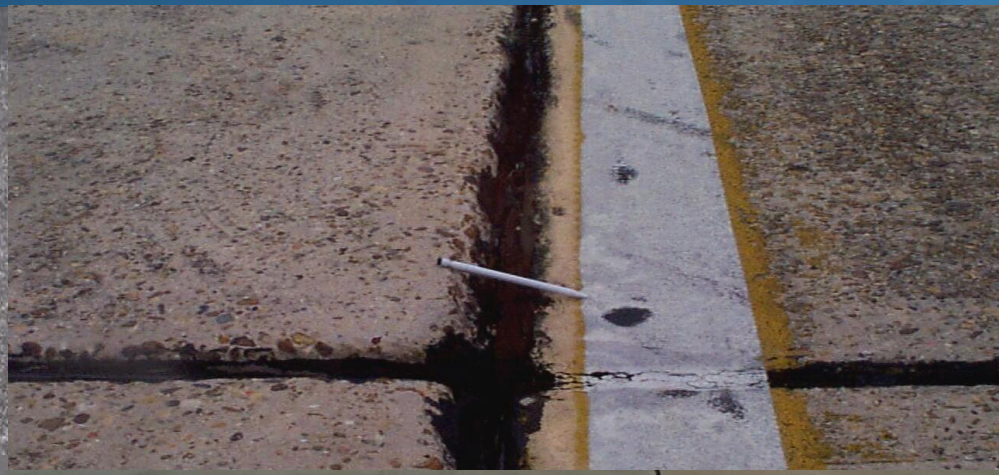
PRESENTATION OUTLINE

- Pavement Damage - Structural
- Typical Repair Methods
- Alternative Repair Method – Precast Panels
- Background
- Applications
- Design Considerations

PAVEMENT DAMAGE

- Portland cement concrete (PCC) pavement is not indestructible
- PCC damage can include:
  - Slab cracking
  - Shattered slabs
  - Corner breaks
  - Joint spalling

PCC DISTRESS



WHY IS THIS A PROBLEM?

- Loss of serviceability
- Reduced structural performance
- Can generate foreign object damage (FOD)

TRADITIONAL REPAIR METHOD

- Full depth repair and/or slab replacement
- Conventional PCC
  - Similar properties to original PCC
  - Generally good performance
  - Long curing period
- High early PCC
  - Availability to aircraft in a few hours
  - Can have durability issues

SLAB REPLACEMENT

- The most common repair technique
- Remove damaged slab

SLAB REPLACEMENT

- Re-grade and compact substrate

SLAB REPLACEMENT

- Install load transfer devices

SLAB REPLACEMENT

- Place and cure concrete

TRADITIONAL SLAB REPLACEMENT

- Repair with conventional concrete:
  - High level of durability and long service life
  - Must achieve minimum strength for traffic availability
    - Minimum 14 days without testing confirmation
- Repair with fast track / high early concrete
  - Can traffic aircraft within hours
  - Reduced durability and service life not uncommon

ALTERNATIVE REPAIR METHOD

- Precast Concrete Slabs

PRECAST PAVING BACKGROUND

- Early soviet trials in the 1930/1940's
- Increased North American use since the 1990's
- Used primarily for rapid repair & rehabilitation
- Panels fabricated off-site, transported to project site & installed on a prepared foundation
- Advantageous for night work & short work windows

PRECAST PAVING BACKGROUND

- Highway experience is more extensive
  - Smaller slab sizes easier to work with
- Airfield usage includes:
  - Calgary International Airport
    - Early 1990's – 13 slabs
  - LaGuardia Airport
  - Washington Dulles International Airport

ADVANTAGES OF PRECAST

- Better control of material quality
  - Manufactured under controlled conditions
  - Conventional concrete mixes
  - Slabs are reinforced
  - May be pre-stressed

ADVANTAGES OF PRECAST

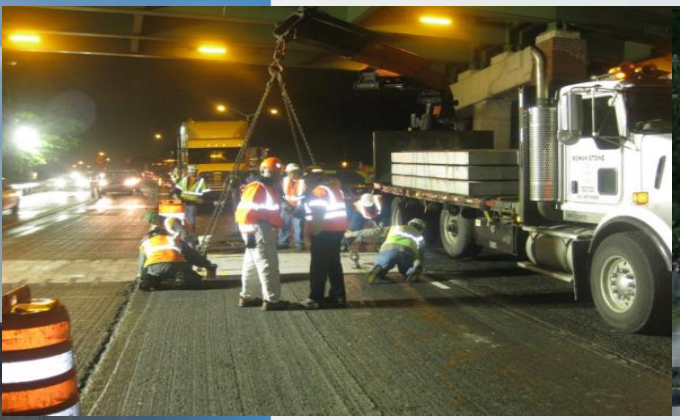
- Fabricated in advance and stored until needed
  - Panel size must be predictable
- Less sensitive to weather conditions
  - Field curing not required – hot and cold extremes
  - Rain damage not an issue

DISADVANTAGES OF PRECAST

- Higher cost
  - Significantly higher than conventional cast in place
  - Higher than fast track
- Size and weight of panels
  - Specialized equipment (cranes, etc) required
- Specialized crews for lifting, leveling, and grouting

APPLICATIONS

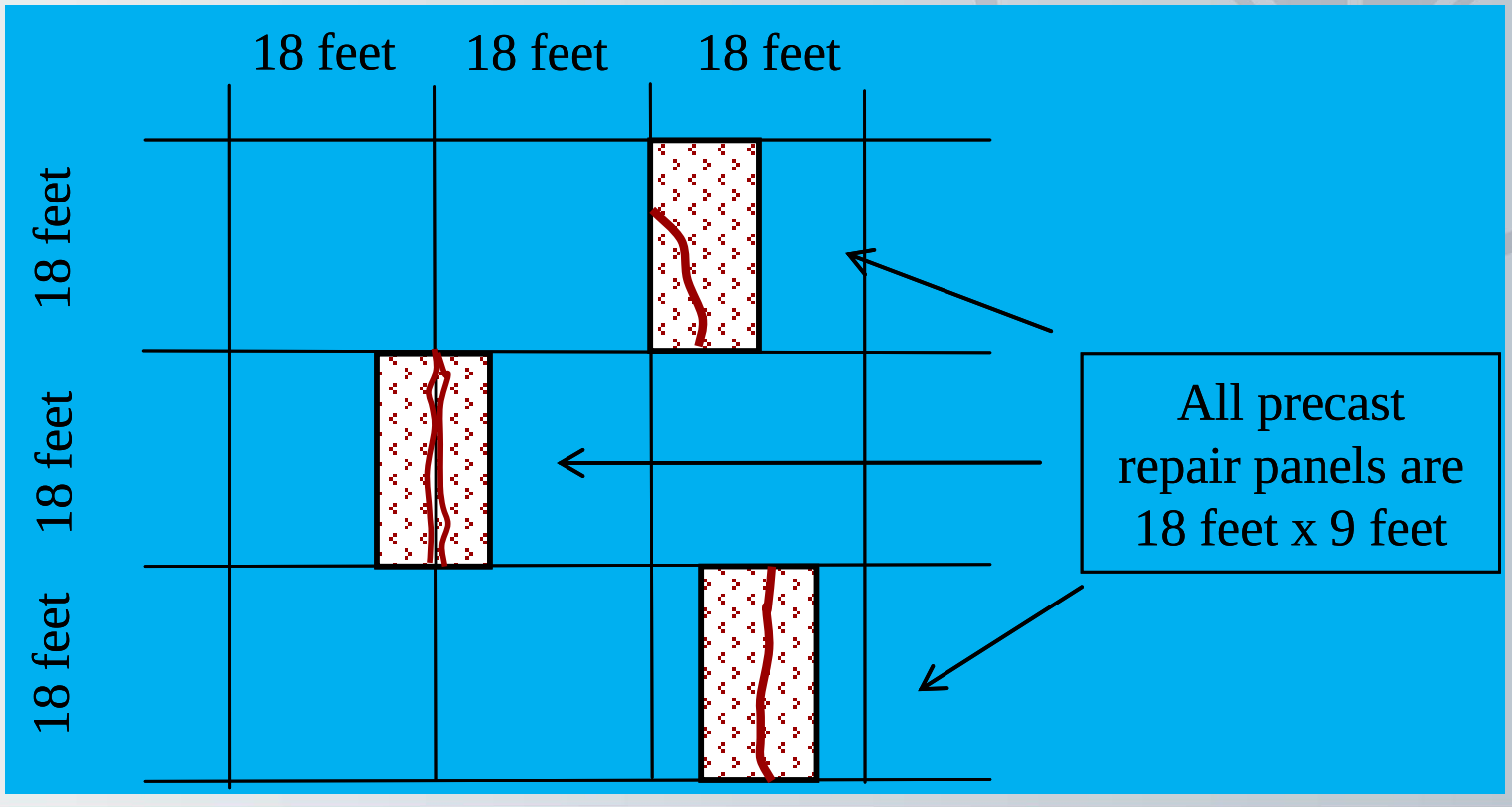
- Single and multiple slab replacement
  - Nominally reinforced panels (common)
  - Pre-stressed panels (typically longer/wider panels)



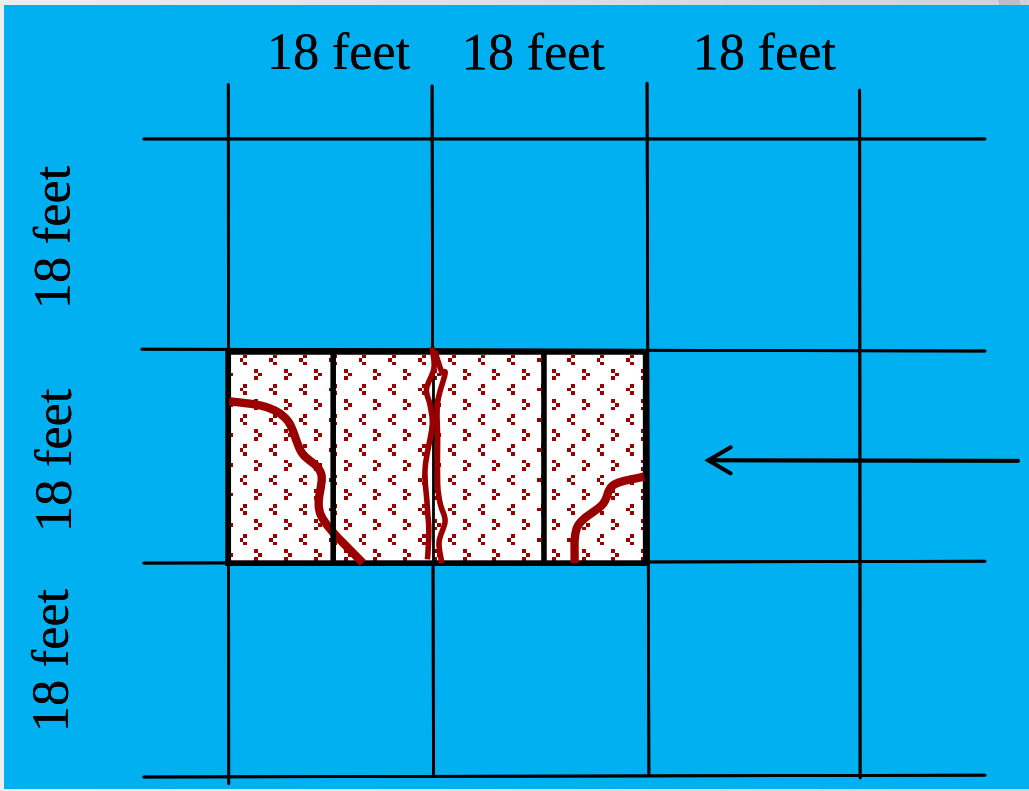
SINGLE SLAB REPLACEMENT

- Replacement of one panel only or partial panel
- Can be considered for a number of applications including
  - replacement of a shattered slab
  - full depth crack repair
  - full depth joint repairs

SINGLE SLAB REPLACEMENT



MULTIPLE SLAB REPLACEMENT

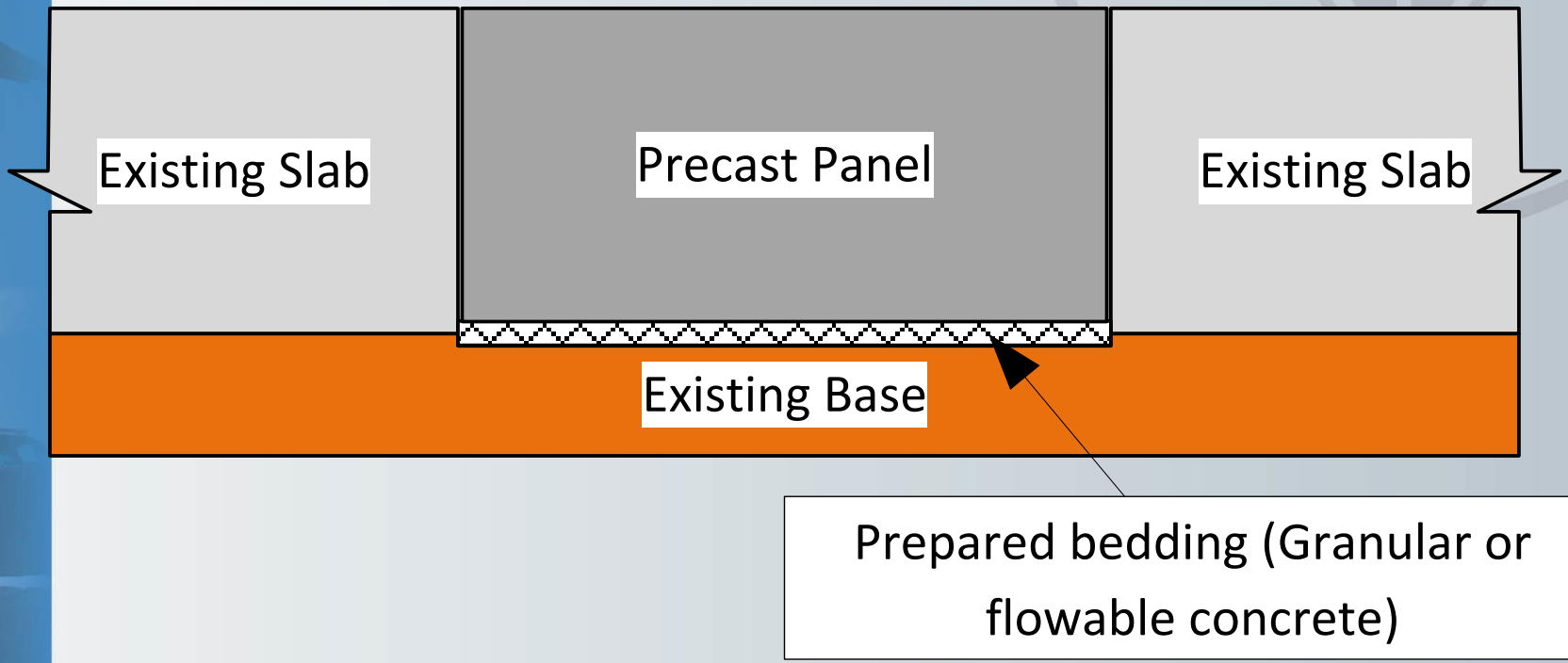


All precast repair panels are 18 feet x 9 feet

PRECAST SYSTEMS

Method	Load transfer	Base support
Fort Miller Super-Slab®	Dowels inserted into the existing pavement	Manufactured sand followed by grouting
Michigan	Dowels cast into the precast panel	Flowable fill
URETEK	Fibreglass ties inserted after the precast panel is placed	Grouting using injected polyurethane foam
California Barra Glide system	Dowels ‘slide into receiving hole	Flowable grout and leveling plates
Other	Various modifications	Any of the above

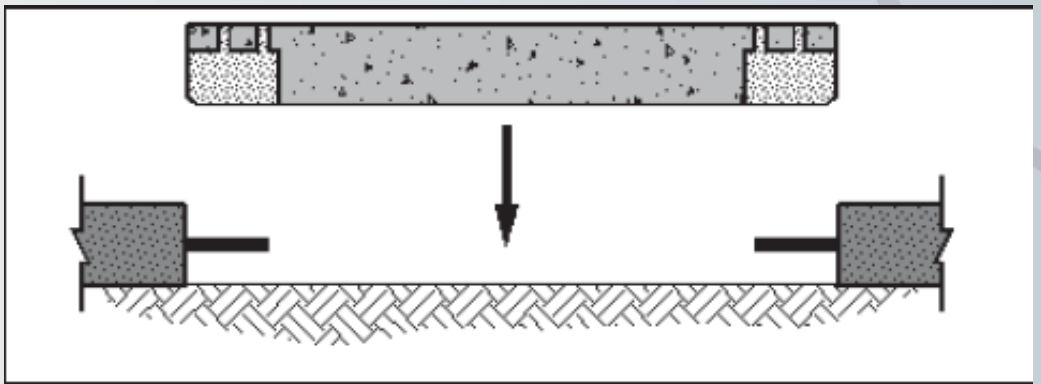
BASIC CONCEPT – ON BEDDING



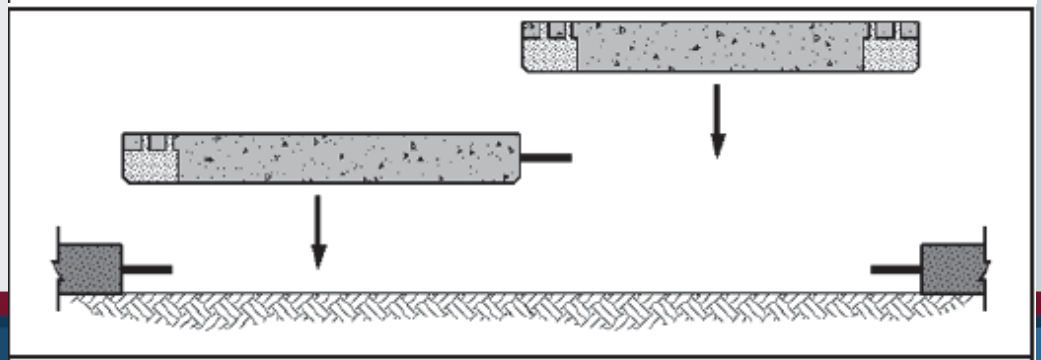
FORT MILLER SYSTEM

FORT MILLER SYSTEM

- Load transfer – bottom slot system



Single-Panel Application



Multiple-Panel Application

FORT MILLER - BASE PREP

- 1st night
- Thin granular layer to set base grade
- Leveled with a screed
- Form release agent to prevent dowel grout bond

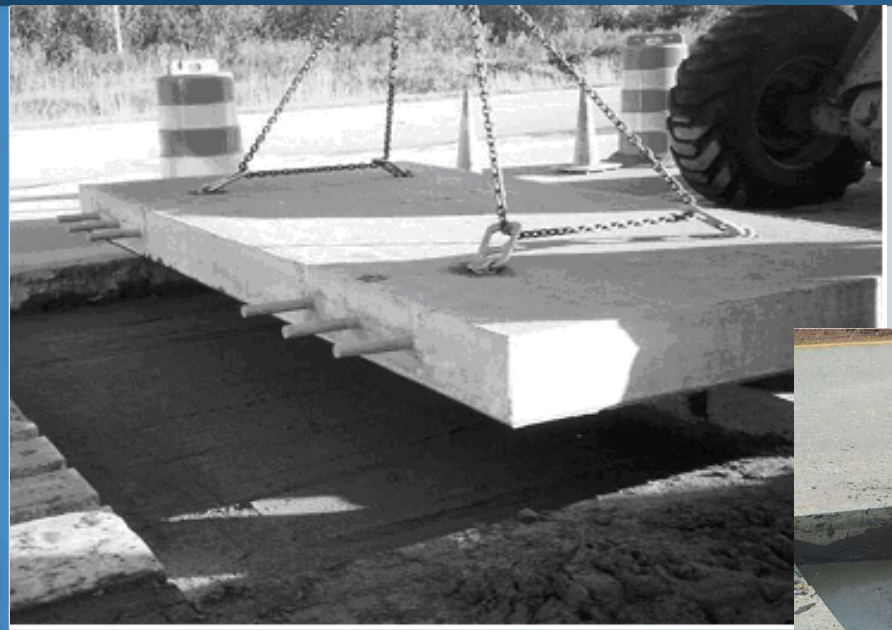
FORT MILLER - PLACEMENT

- 1st night
- Set panels

FORT MILLER – GROUTING

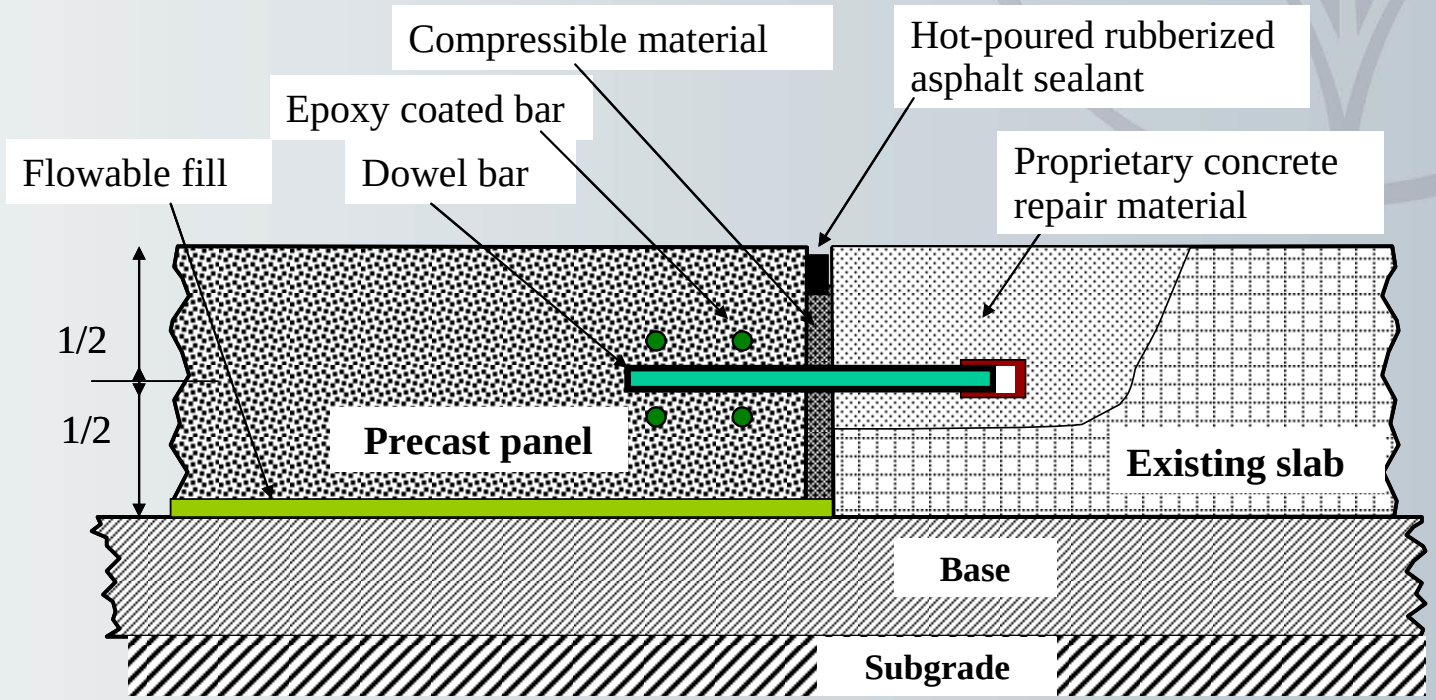
- 2nd night
- Inject flowable bedding grout
- Inject dowel grout

MICHIGAN METHOD



MICHIGAN METHOD

- Load transfer – top slot system



MICHIGAN - BASE PREP

- Cementitious self-levelling flowable fill

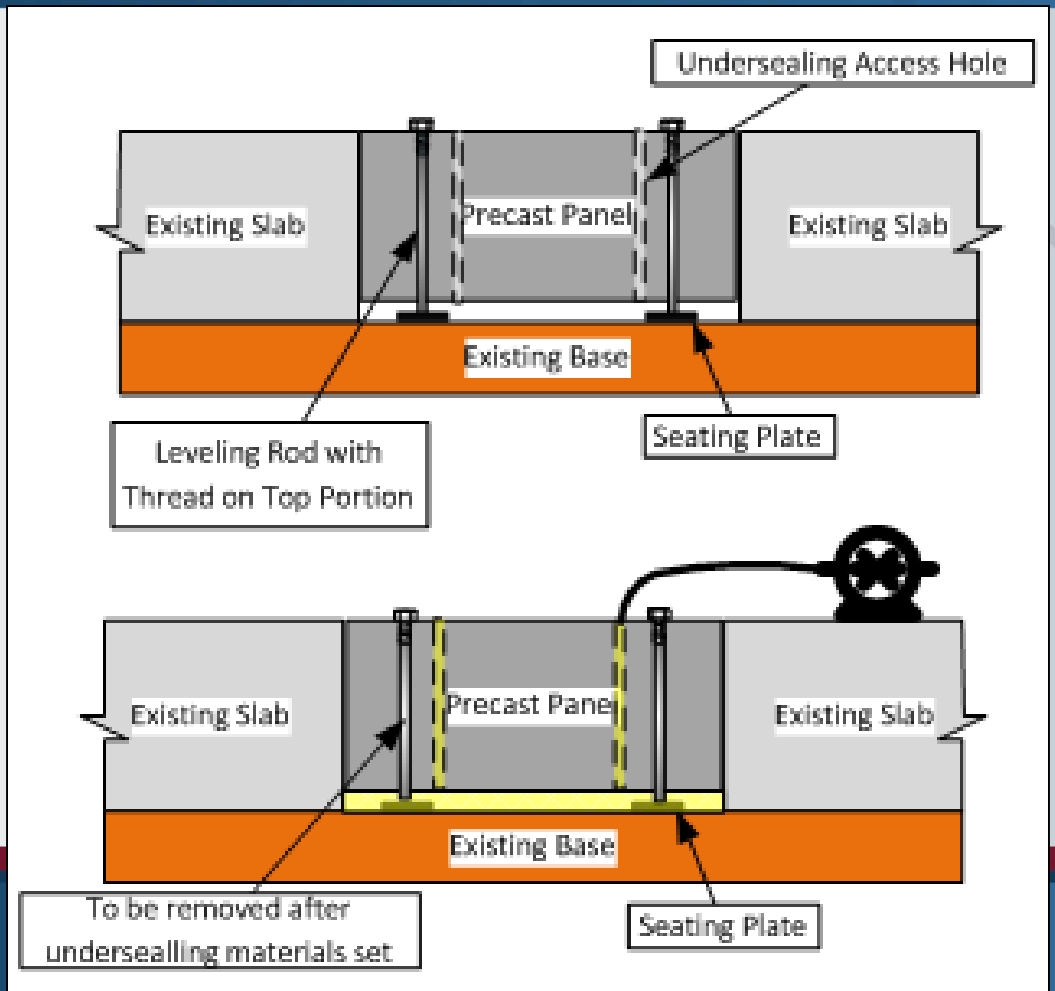
MICHIGAN - COMPLETED

- Method modified by US Air Force for rapid theater of operation use

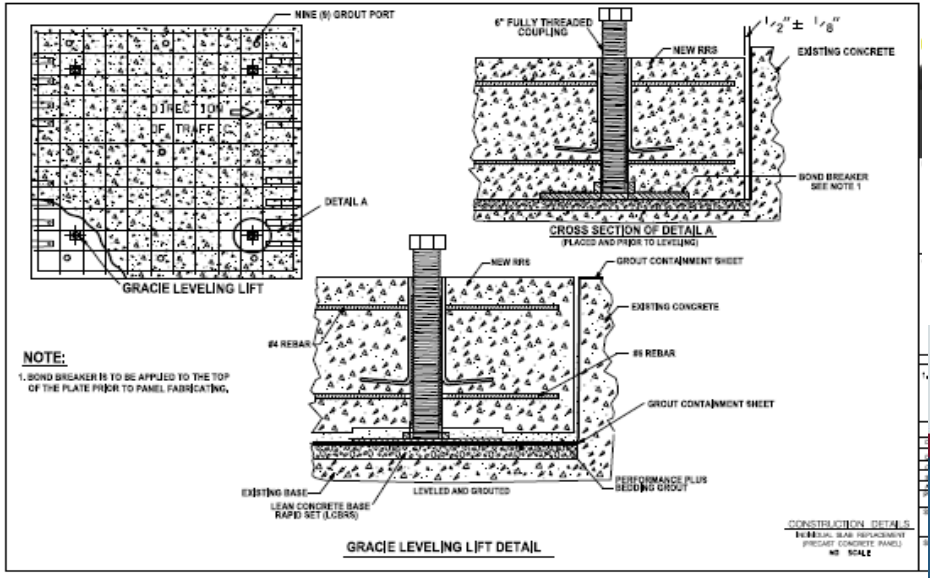
URETEK METHOD

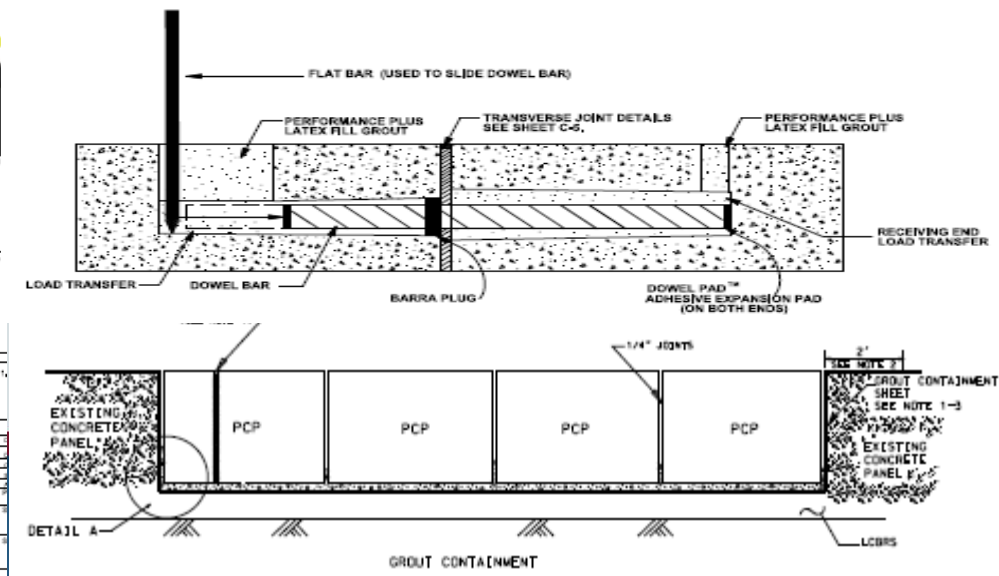
- Precast panels with no dowels
- High density polyurethane foam to lift and level slab
- Fibreglass ties to restore load transfer

BASIC CONCEPT – LEVELING BOLTS



BARRA GLIDE LT / GRACIE LIFT





CASE STUDY – LAGUARDIA TAXI D-D

- Opened in 1939
- Congested taxiways
- Flexible pavement has grown thick
- Premature rutting issues

Courtesy of Scott Murrell

LAGUARDIA - CONSTRUCTION

- Mill existing pavement (100 ft x 50 ft)
- Set steel bearing plates
- Install panels (12.5 ft x 25 ft, 16 in thick)
- Inject grout
- Fill dowel slots
- Joint seal and pavement marking
- Completed over a 36 hour weekend closure

LAGUARDIA

Milling of Existing Asphalt Concrete Pavement
(7:00 AM to 2:00PM)

LAGUARDIA

Installation of Steel Bearing Plates
(2:00PM to 7:00PM)

LAGUARDIA

Installation of Precast Concrete Panels
(7:30PM to 2:30AM)

LAGUARDIA

Installation of Precast Concrete Panels (continued)

LAGUARDIA

Installation of Cement Grout Bed
(3:00 AM to 12:00 PM)

LAGUARDIA

Installation of Cement Grout Bed (continued)

LAGUARDIA

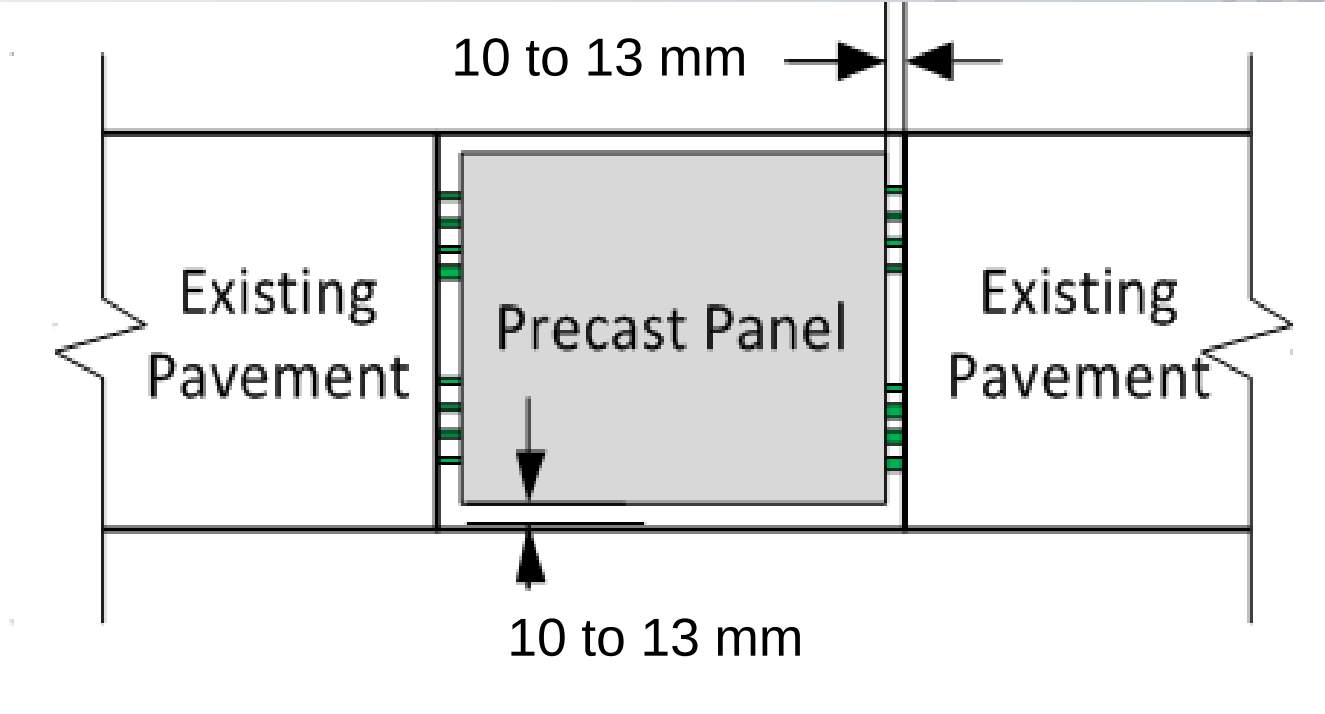
Dowel Slots Filled with Concrete

LAGUARDIA

Joint Sealing, Pavement Markings and Asphalt Paving (12:30 PM to 7:30 PM)

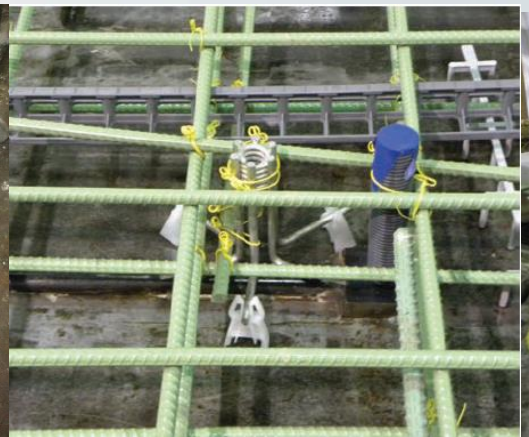
DESIGN CONSIDERATIONS

- Precast Panel must be slightly undersized



DESIGN CONSIDERATIONS

- Panel Handling
  - 4 point lift required
  - Lifting hardware left in place must have 70 mm top cover and 50 mm bottom cover after installation
  - PCI provides guidance on lift anchor locations

PANEL WEIGHT

Panel Size (ft)	Panel Thickness (in.)	Panel Weight (lb)	Four-Point Lift Anchor Load (Static) (lb)
12 x 6	8	7,000	1,750
	10	8,700	2,175
	12	10,400	2,600
12 x 12	8	13,900	3,500
	10	17,300	4,325
	12	20,800	5,200
12 x 15	8	17,300	4,325
	10	21,600	5,400
	12	26,000	6,500
12 x 20	8	23,100	5,775
	10	28,800	7,200
	12	34,600	8,650
12 x 36	8	41,500	10,375
	10	51,900	12,975
	12	62,200	15,550

STATIC LIFTING FLEXURAL STRESSES

Panel Length (ft.)	Panel Width (ft.)	Panel Thickness (in.)	Maximum Concrete Lifting Stress (psi)
10	12	9	39
	24	9	154
	36	9	347
	12	10	35
	12	11	32
	12	12	29
12	12	9	39
	24	9	154
	36	9	347
	12	10	35
	12	11	32
	12	12	29
15	12	9	60
	24	9	154
	36	9	347
	12	10	54
	12	11	49
	12	12	45

As a panel dimension gets longer, pretensioning becomes necessary

PCI guidelines (PCI 2004)

SELECT REFERENCES

AFRL-RX-TY-TR-2009-4588

PRECAST SLAB LITERATURE REVIEW REPORT: REPAIR OF RIGID AIRFIELD PAVEMENTS USING PRECAST CONCRETE PANELS—A STATE-OF-THE-ART REVIEW

Chris Olidis, D.J. Swan and Athar Saeed
Applied Research Associates, Inc.
P.O. Box 40128
Tyndall Air Force Base, FL 32403

R. Craig Mellerski and Michael I. Hammons
Airbase Technologies Division
Air Force Research Laboratory
139 Barnes Drive, Suite 2
Tyndall Air Force Base, FL 32403-5323

Contract No. FA4819-07-D-0001

June 2010

DISTRIBUTION A: Approved for public release; distribution unlimited.

AIR FORCE RESEARCH LABORATORY
MATERIALS AND MANUFACTURING DIRECTORATE

■ Air Force Materiel Command ■ United States Air Force ■ Tyndall Air Force Base, FL 32403-5323

ERDC/GSL TR-15-10

Geotechnical and Structures Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

ERDC
INNOVATIVE SOLUTIONS for a safer, better world

Evaluation of Precast Portland Cement Concrete Panels for Airfield Pavement Repairs

Lucy P. Priddy

May 2015

Approved for public release; distribution is unlimited.

REPORT S2-R05-RR-1

Precast Concrete Pavement Technology

SHRP2 RENEWAL RESEARCH

SHRP 2
STRATEGIC HIGHWAY RESEARCH PROGRAM
Accelerating solutions for highway safety, renewal, reliability, and capacity

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

ARA

HIGHWAY CASE STUDIES - 2016

Hawaii

FHWA PROJECT 805 IAF FUNDED PROJECT CASE STUDY

HONOLULU INTERSTATE H1 PRECAST CONCRETE PAVEMENT DEMONSTRATION PROJECT

October 2016

Wisconsin

FHWA PROJECT 805 IAF FUNDED PROJECT CASE STUDY

MADISON BELTLINE PRECAST CONCRETE PAVEMENT DEMONSTRATION PROJECT

October 2016

Kansas

FHWA REPORT NO. FHWA-HIF-17-005

FHWA PROJECT 805 IAF FUNDED PROJECT CASE STUDY

LEAVENWORTH PRECAST CONCRETE PAVEMENT DEMONSTRATION PROJECT

Connecticut

FHWA-REPORT-NO. FHWA-HIF-17-015

FHWA PROJECT 805 IAF FUNDED PROJECT CASE STUDY

NEW BRITAIN BUS PADS PRECAST CONCRETE PAVEMENT DEMONSTRATION PROJECT

Texas

FHWA-REPORT-NO. FHWA-HIF-17-017

FHWA PROJECT 805 IAF FUNDED PROJECT CASE STUDY

TEXAS PRECAST CONCRETE PAVEMENT INTERSECTION DEMONSTRATION PROJECT

December 2016

Questions ?