



C-17 CERTIFICATION OF AIRFIELD DAMAGE REPAIR KITS

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Sponsored By:

U.S. Air Force Air Mobility Command

U.S. Air Force C-17 System Program Office

U.S. Air Force Civil Engineer Support Agency

PROBLEM

PROBLEM: Current DoD ADR Kits Not Tested for C-17 Aircraft

IMPACT: FOD Covers Not Allowed Due to Projected Shear Forces
Intense Engineer Effort Required to Sustain Operations
Restricted Operations Tempo to Conduct Repairs

Aircraft Comparison:

	C-17	C-130
Aircraft Weight	502,000 lbs	155,000 lbs
Wheel Load	38,500 lbs	34,875 lbs
Gross Gear Load	230,920 lbs	69,750 lbs



OEF/OIF Crater Repair Methods Used:

- **Compacted Soil – High FOD/Maintenance**
- **Stabilized Soil – Better Performance FOD/Maintenance**
- **PCC – Difficult Obtaining Materials/Equipment**
- **Rapid Setting Materials – Bonding/FOD**





A

B1

B2

Runway 5/23
10,500' x 148'

C1

Taxiway F
10,500' x 75'

C2

Main
Apron

D1

D2

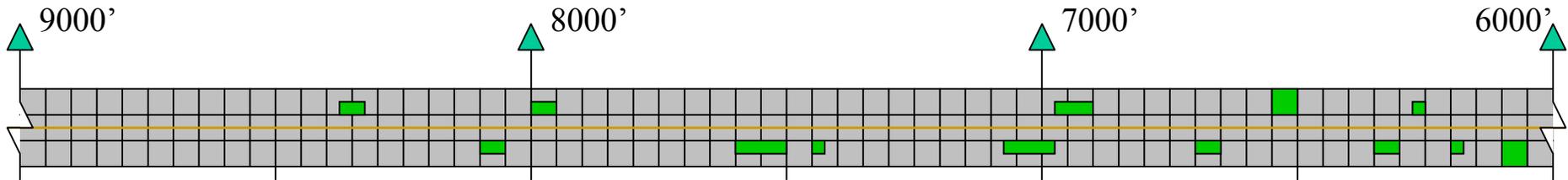
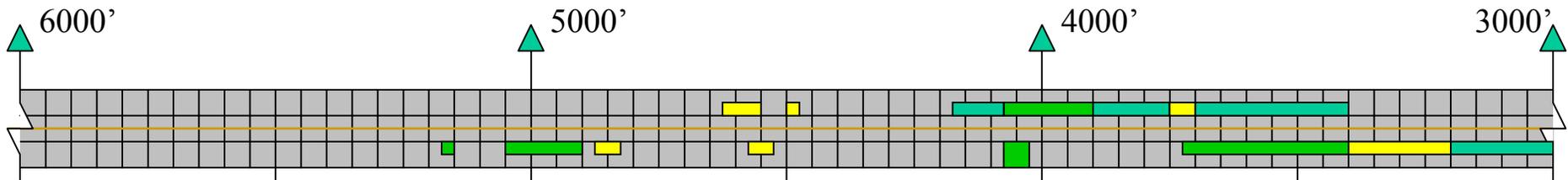
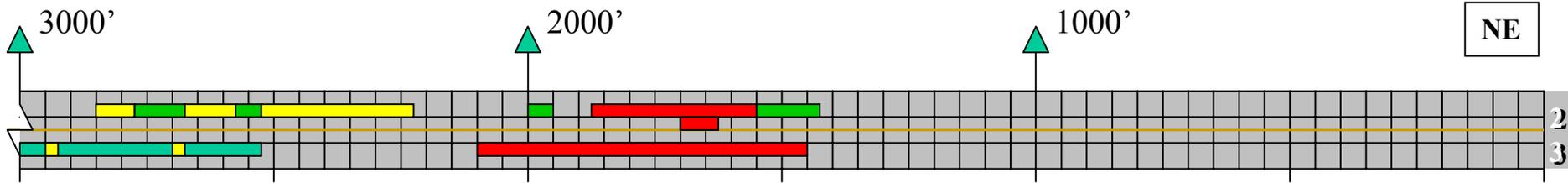
Hanger
Apron

E



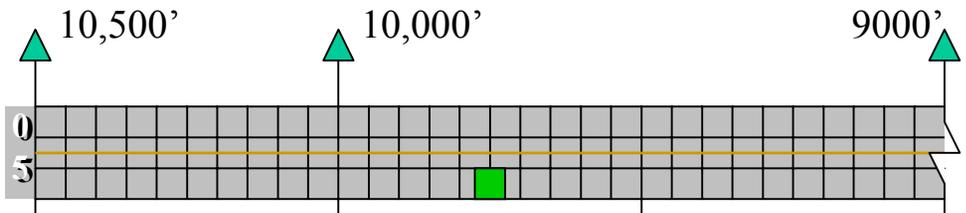
KANDAHAR IAP, AFG

R/W DAMAGE



REPAIR LEGEND

- CONCRETE PATCH
- STABILIZED DIRT
- NEEDS REPAIR / TEMPORARY
- FAILING



KANDAHAR, AFG DAMAGE REPAIR - STATUS

Station	Position	Size (ft.)	Date Complete	Type of Repair
14+60'	Right	74x14	2-Feb-02	8-12" Concrete w/ pickets 2'x2' squares
14+70'	Left	670x13	Under Const.	10" Concrete w/ 2'x2' rebar, 4" rock base
15+40'	Right	340x13	Under Const.	10" Concrete w/ 2'x2' rebar, 4" rock base
16	Left	22x11	24-Jan-02	6-8" Concrete w/ pickets 2'x2' squares
16+20'	Center Right	56x11	23-Jan-02	6" Concrete w/ pickets 2'x2' squares (failed)
		69x19	Under Const.	10" Concrete w/ 2'x2' rebar, 4" rock base
19+60'	Right	35x15	3-Feb-02	16" Concrete w/ rebar
22+40'	Right	290x14	Needs Repaired	10" Concrete w/ rebar
25+25'	Right	55x11	17-Feb-02	10" Stabilized Dirt with type I cement
		61x11	27-Feb-02	10" Concrete w/ rebar, 8" rock base
25+80'	Right	110x15	Needs Repaired	10" Concrete w/ rebar
26	Left	600x14	Failing / NR	10" Concrete w/ rebar
26+90'	Right	70x20	17-Feb-02	10" Stabilized Dirt with type I cement
			28-Feb-02	10" Concrete w/ 2'x2' rebar, 8" rock base
27+50	Right	110x15	Needs Repaired	10" Concrete w/ rebar
32	Left	200x12	Needs Repaired	10" Concrete w/ rebar
34	Right	300x10	Failing	10" Concrete w/ rebar
34	Left	340x10	9-Feb-02	Stabilized Dirt 4" w/ type I cement
			4-Mar-02	10" Concrete w/ 2'x2' rebar, 4" rock base
37	Right	50x11	Needs Repaired	10" Concrete w/ rebar
37+50	Right	150x11	Failing	10" Concrete w/ rebar
39	Right	(65x18)+(90x10)	9-Feb-02	Stabilized Dirt w/ sand-grid, 4" cap with type I cement
			6-Mar-02	10" Concrete w/ 2'x2' rebar, 4" rock base
40+30'	Left	32 (L est.)	~~	Concrete Seabee Repair
40+55'	Right	100x11	Failing	10" concrete w/ rebar

Station Number refers to distance measured down the runway from NE to SW in hundreds of feet
 i.e. 14+60' refers to 1460 ft from the NE end of the runway

CERTIFICATION OVERVIEW

➤ Procure Existing Kits

- FFM – Rapid Mat LLC/RRR Inc./Tankinetics
- FRP – GFI, Inc./Tankinetics
- AM2 – ALFAB

➤ Conduct Bearing Capacity Testing of Each Expedient Repair Technique

- C-17 Multiple-Wheel Load Cart (6 Bogies for Minimum of 100 Passes)
- 25-ft Craters in Composite Pavement Section
- Evaluate Load Support, Connection Stability, Roughness Criteria

➤ Horizontal Shear Tests:

- Locked-Wheel Single-Wheel Load Cart Tests
- Horizontal Drawbar Pull
- Evaluate Anchor Bolts and Systems

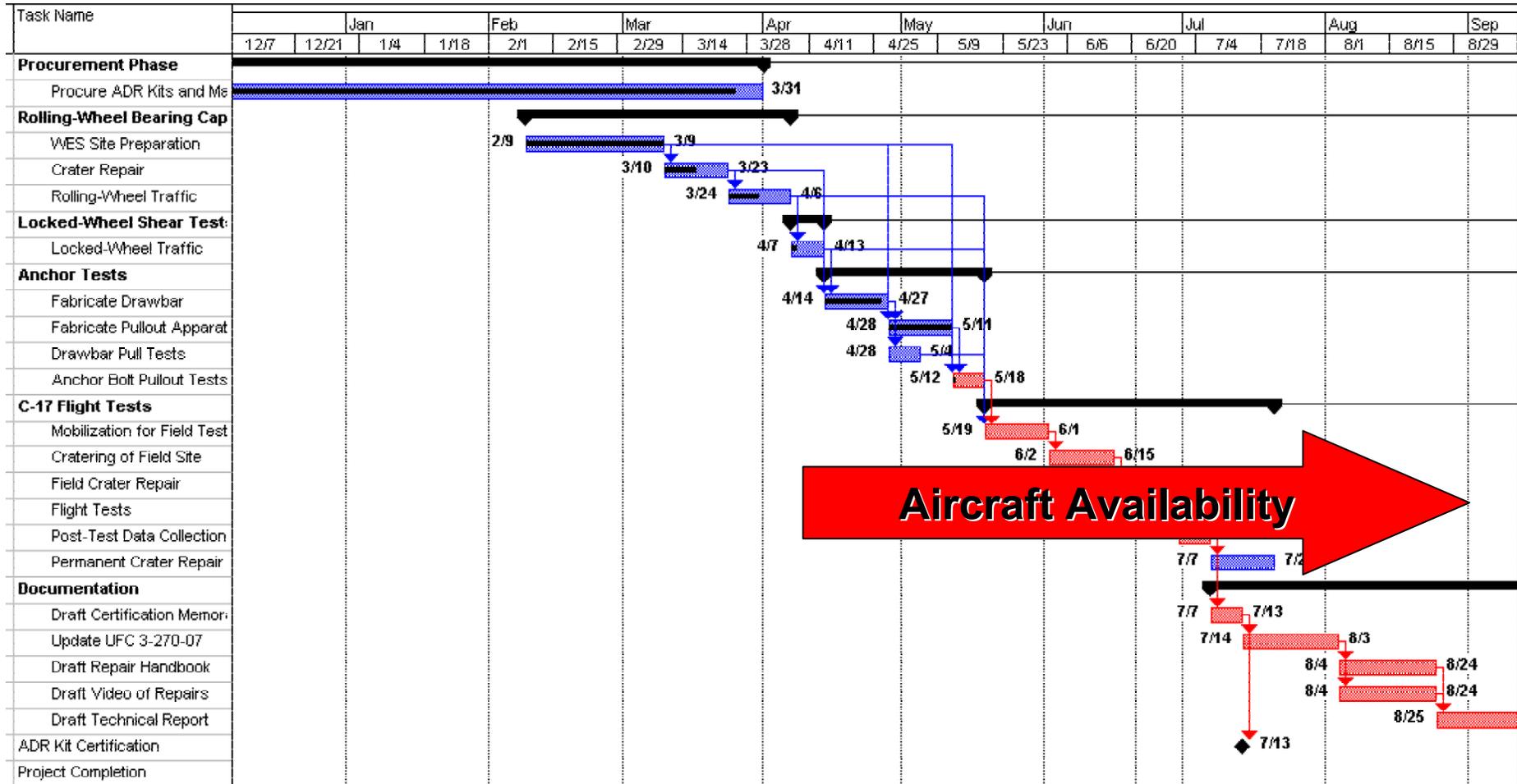
➤ Shear Testing of Anchor Bolts:

- Measure Pullout Strength and Compare to C-17 Estimated Shear Loads
- Evaluate Ease of Installation of Anchor Bolts

➤ Conduct Controlled Flight Tests:

- Subject Surviving Kits to Live-Flight Tests
- Increasing Aircraft Weights
- Final Certification of Kits

PROJECT STATUS



Aircraft Availability

CRATER REPAIR – SERIES 1

- **Can Expedient Repairs Sustain the Gross Aircraft Load?**
- **Conduct Load Testing of Each Expedient Repair Technique**
 - **C-17 Multiple-Wheel Load Cart (Min. 100 Passes)**
 - **25-ft Craters in Flexible Pavement Surface**
 - **Evaluate Load Support, Connection Stability, Roughness Criteria**

First Crater Series: (580-Kip C-17)

- **FRP Over 2 Layers of Sand Grid (Army Standard)**
- **AM2 Over 18-in. of Crushed Stone (Taxiways and Aprons Only)**
- **FFM Over 18-in. of Crushed Stone (Air Force Cold War Standard)**
- **FFM Over 2 Layers of Sand Grid (Air Force Airborne Red Horse)**



CRATER REPAIR – SERIES 1



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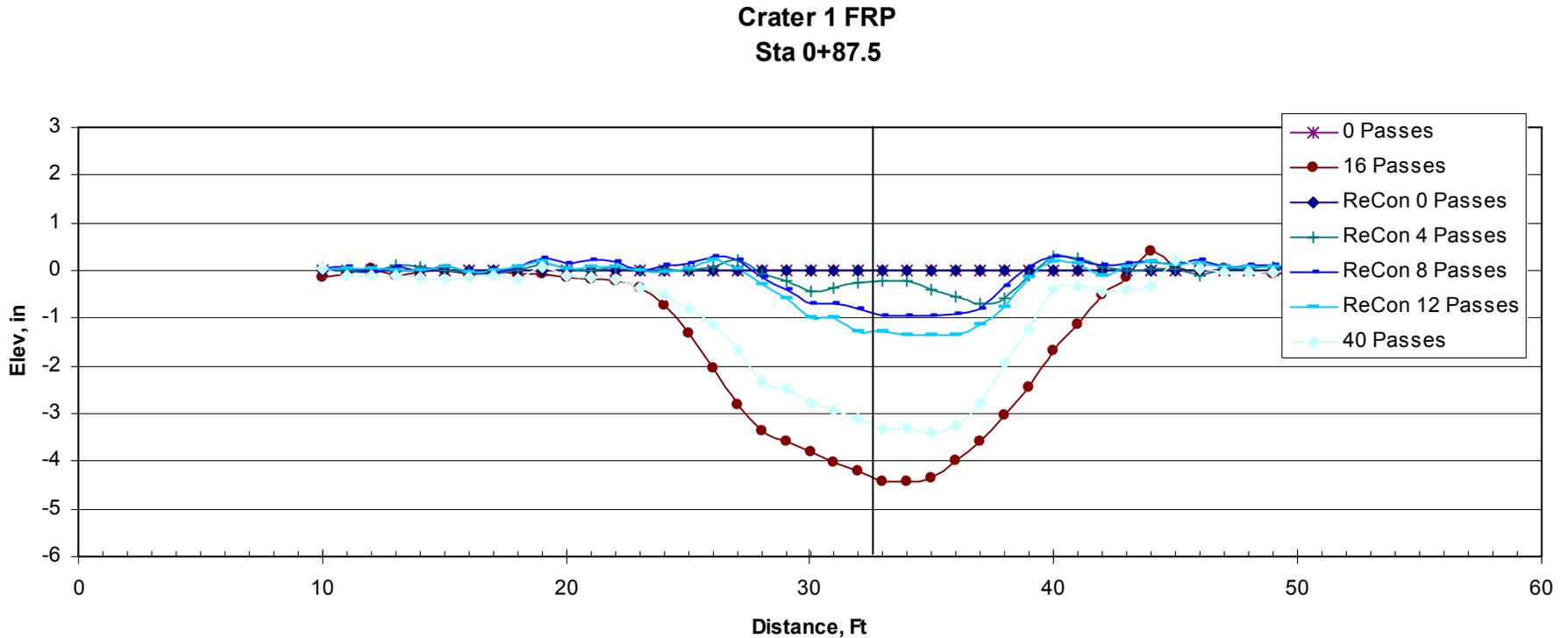
CRATER REPAIR – SERIES 1

➤ Conduct Load Testing of Each Expedient Repair Technique

- C-17 Multiple-Wheel Load Cart (Min. 100 Passes)
- 266,800 lbs Gross Weight/44,500-lb Wheel Loads/142 psi Tire Pressure
- 25-ft Craters in Composite Pavement System
- Evaluate Load Support, Connection Stability, Roughness Criteria



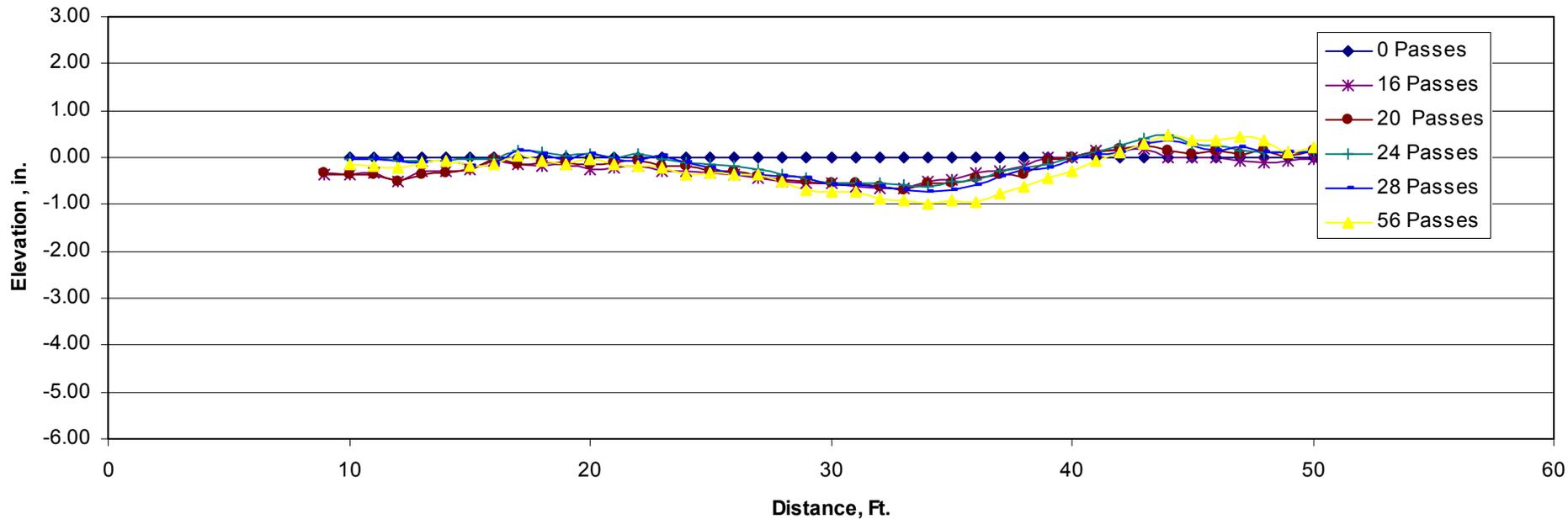
CRATER REPAIR – SERIES 1



FRP Over Sand Grid: 5-in. Sag at 84 Passes

CRATER REPAIR – SERIES 1

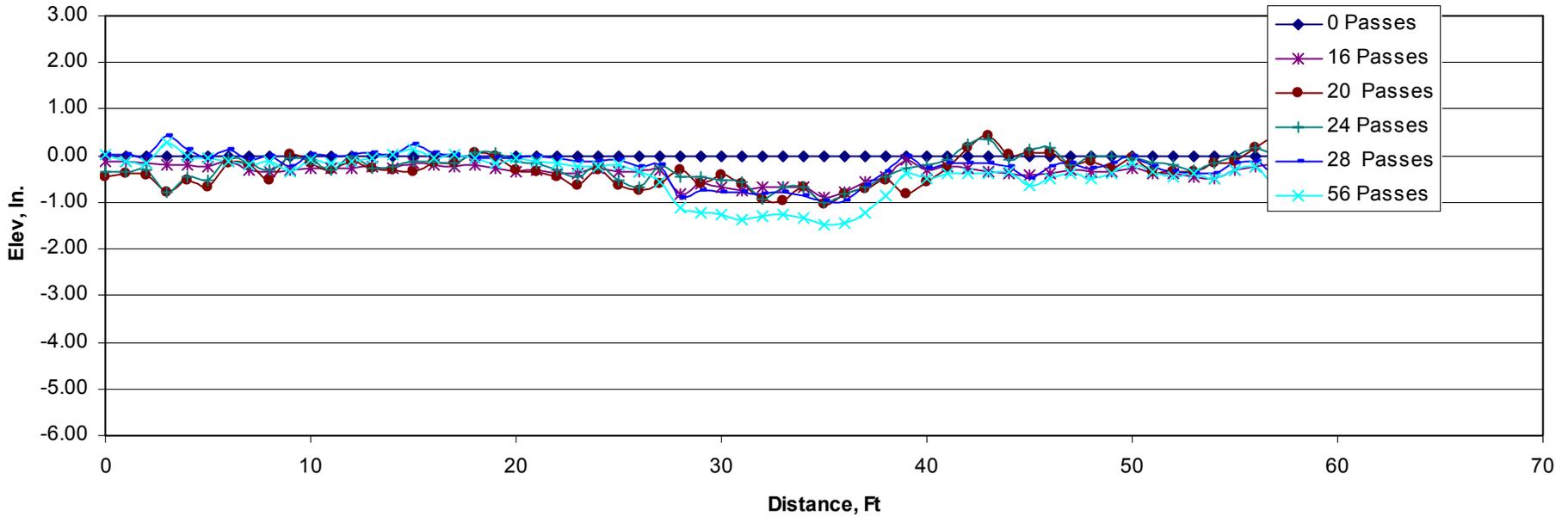
Crater 2- AM-2 Mat
Sta 1+37.5



AM-2 Mat Over 18-in. Crushed Stone: 1-in.+ Sag at 100 Passes

CRATER REPAIR – SERIES 1

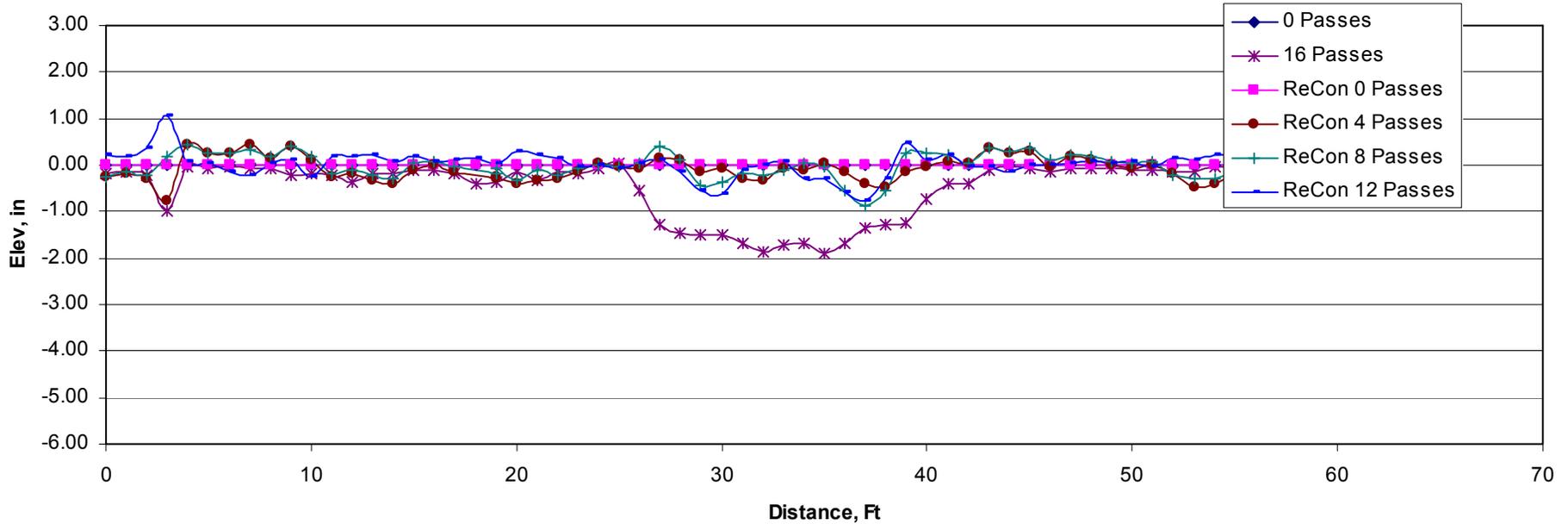
Crater 3 FFM
Sta 1+87.5



FFM Over 18-in. Crushed Stone: 2-in. Sag at 100 Passes

CRATER REPAIR – SERIES 1

Crater 4 FFM Delhi
Sta 2+37.5



FFM Over 2 Layers of Sand Grid: 3.5-in. Sag at 84 Passes

AIRFIELD DAMAGE REPAIR

➤ Are the Current Anchor Bolts the Best and Strongest?

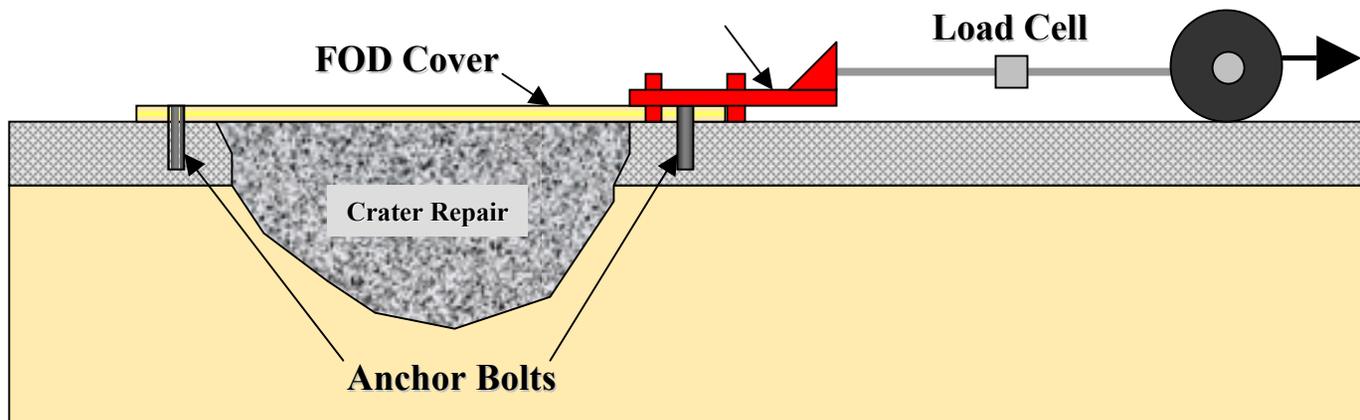
➤ Locked-Wheel Single-Wheel Load Cart Tests:

- Simulated Braking Over the Mat Systems
- 38,500-lb Wheel Load and 142 psi Tire Pressure
- Measure Shear Forces
- Evaluate Anchor Bolts and Systems



➤ Shear Testing of Anchor Bolts:

- Procure 30 COTS Anchor Bolts
- Measure Pullout Strength and Compare to C-17 Estimated Shear Loads
- Evaluate Strength and Ease of Installation



Profile View

ANCHOR BOLT TENSILE TESTS

➤ Shear Testing of Anchor Bolts:

- Measure Pullout Strength and Compare to C-17 Estimated Shear Loads
- Over 30 Commercial Anchor Bolts Procured
- Minimum of 3 Replicates



AIRFIELD DAMAGE REPAIR

➤ Conduct Controlled Flight Tests:

- Subject Surviving Kits to Live-Flight Tests
- Mackall AAF – Aug-Sep 2004
- Rwy 11-29: 150-ft by 4,750-ft
- 6” PCC w/ Flex Strength 650 psi over SP-SM
- Recent NDT Tests
- Taxi Operations, Rejected Takeoffs (RTOs)
- 10 Landings at Increasing Aircraft Weights
- Final Certification of Kits



Upgrade Possibilities

Possible Upgrade Items:

➤ Evaluate Multi-Purpose Fiberglass Mat

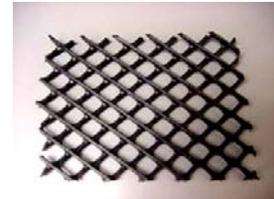
- Reduced Logistics
- Easier to Handle
- Working on Trade-Mark as ACE-Mat



➤ Evaluate New Anchor Bolts

➤ Evaluate Geosynthetics for Reinforcement of Marginal Materials

- Geogrids for lateral restraint of aggregate
- Drainage composites for separation and reinforcement
- Membranes versus geotextiles



➤ Evaluation of Reduced Footprint Equipment

- Skid Steer Attachments
- Portable rock crushers
- Small concrete batch mixers



Discussion

