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Date: July 30, 2010

To: FDOT Research Center c/o Sandra Bell
From: A. Sagüés, Principal Investigator (PI) Project BDK84 977-06
cc.: Sastry Putcha, FDOT Technical Coordinator
Mario Paredes, FDOT State Materials Office

Subject: **Quarterly Progress Report – 4th Quarter: 4/1/10 - 6/30/10**
Project BDK84 977-06: "Reinforced Concrete Pipe Cracks -Acceptance Criteria" (USF # 2104112600).

1) Activities performed this quarter:

Based on correspondence and teleconference on 4/15/10 with Technical Coordinator and stakeholders a laboratory test plan was finalized, approved on 4/27/10 and is attached as Appendix 1.

Class III B-Wall (2" wall) 8' x 18" reinforced concrete pipes from current production were obtained by donation, two each from two manufacturers regularly producing pipe for FDOT projects, 4 pipes total.

The pipes were cut at the FDOT SMO per the following plan (Figure 1) :

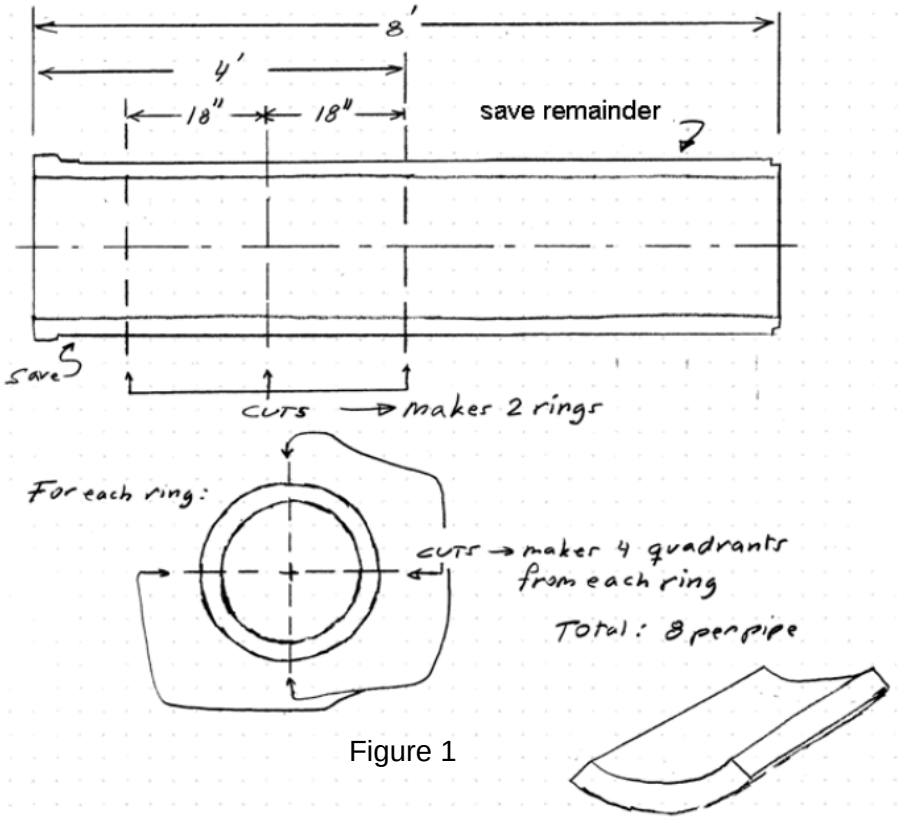

Figure 1

Pipes were delivered to USF and cataloguing and characterization commenced. A pipe cracking rig was designed (Figure 2) and crack operation confirmed and refined with a trial specimen.

Figure 2

2) Activities Planned for Next Quarter:

- Complete pipe section cataloguing and characterization.
- Finish crack rig calibration and conduct controlled cracking and of all 24 cracked specimens.
- Conduct Stage A (Appendix 1) preliminary exposures.
- Initiate Stage B (Appendix 1).

3) Summary of Requested Modifications:

None at present, but it is noted that personnel availability has been limited in May and June due to temporary leave of a Graduate student. Elaboration and USF/FDOT technical development of the final test plan also required added time. As stage A nears completion needs for adjustment on remaining schedule (if any) will be consulted at that time with the project manager.

4) Progress Schedule:

See next page.

PROJECT SCHEDULE

Project Title Reinforced Concrete Pipe Cracks - Acceptance Criteria
FDOT Project No. BDK84 977-06 **FY** 2008-9 **Month** 12
Research Agency University of South Florida
Principal Investigator Dr.Alberto A. Sagues

RESEARCH TASK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21				ESTIMATED % COMPLETION
Task 1																									
Lit. Rev.	33	66	100																						95%
Task 2																									
Final approach				100																					100%
Task 3																									
Conduct Rsch.					10	20	25	30	40	50	60	70	75	80	85	90	95	100							35%
Task 4																									
Maximum Width																									0%
Task 5															25	50	75	100							
Draft Specificaton																									
																33	66	100							0%
Final Report																									
																			33	66	100				0%
Overall % Complete Projected	4%	8%	10%	15%	20%	25%	30%	35%	40%	45%	50%	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	100				
Overall % Complete Actual			10%			18%			25%			40%													40%

APPENDIX 1

BDK84 977-06: "Reinforced Concrete Pipe Cracks -Acceptance Criteria"
(USF # 2104112600).

Laboratory Testing Plan - Approved 4/27/10

- Issue on steel corrosion localization effects mentioned in the 3/29/10 draft will no longer be addressed under this project.
- Remaining issue, to be addressed experimentally, is on extent of corrosion that may occur even in the presence of healing.
- Scope of this issue to be expanded to use resources freed by not addressing corrosion localization effects. Example of expansion given below, by considering 2 different pipe manufacturers. Other alternatives possible pending discussion.

Objective: Determine extent of corrosion that can take place in RC pipe cracks with partial or complete autogenous healing.

Rationale: We need to know how much corrosion will take place under the conditions of interest, so that a rational forecast of damage can be made with the predictive model. In particular, there is no assurance that even with a certain amount of crack healing the corrosion process will be effectively arrested. Conversely, it is possible that even partial healing may prove to be highly beneficial in precluding corrosion. These issues are not sufficiently addressed by the present literature and experiments are needed for resolution.

Outcome: Corrosion rate values will be obtained, to be used together with data from literature survey for input in predictive model. Based on severity of projected effect, establish proposed acceptable crack width.

Approach: The testing will be conducted in two stages described below.

STAGE A: PRELIMINARY RANGING TESTS.
Estimated duration: 3 months, concurrent with start of Stage B (please read that first).

These tests will each involve 2 to 4 selected specimens.

A1: Prepare specimens per item 2 in the main test series (Stage B) to ensure that the desired crack widths can be reproducibly created.

A2: After A1 is complete, make preliminary solution exposures per item 3 in the main test series to ensure that adequate crack healing is obtained using the planned (or a modified accordingly) solution chemistry.

STAGE B: MAIN TEST SERIES.
Estimated duration: 9 months, initial 3 months concurrent with Stage A.
Note: number of specimens (extent of effort) left open pending further discussion on scope of the testing.

1. Obtain pipe samples from **Nm** different sources. Pipes will be 24-inch diameter, 8-ft long, obtained in duplicate. Out of each pipe 18-inch long rings will be cut out, and then each ring will be cut into 4 quadrants. Each quadrant is one test specimen. The number of rings to be cut will be determined by the number of specimens **Ns** needed to permit the testing detailed below in duplicate.
2. Load each quadrant in 3 point bending to obtain desired crack width upon springback. **Nc** different crack widths will be tested plus no-crack control.
3. Expose cracked specimens by ponding in water with chemistry that promotes healing (high calcium carbonate precipitation potential). Achieve **Nh** different healing conditions including no-healing with specimens not ponded. Estimated exposure time t_1= 2 months.
4. After the healing treatment, expose all specimens to **Nr** different corrosive environments with low precipitating tendency. Estimated exposure time t_2=4-6 months. Perform periodic visual and non-destructive corrosion testing during exposure.
5. At end of period t_2 perform autopsy of specimens.

Variables determining extent of effort

Number of specimens to be tested **Ns** = 2*Nm*(Nc-1)*Nh*Nr+2*Nm*Nr.
The example below (Expansion: consider 2 pipe manufacturers) requires Ns = 28 specimens.

EXAMPLE			Conditions
Number of manufacturers (i.e. type of concrete/pipe)	**Nm**	**2**	Mfr. 1, Mfr. 2
Number of crack widths (including no-crack control) to be examined	**Nc**	**3**	0 (control), 0.020 in, 0.100 in
Number of healing conditions in addition to no-healing.	**Nh**	**3**	No healing, partial, complete
Number of corrosive environments	**Nr**	**1**	500 ppm Cl with pH<6.5
Total number of specimens tested	**Ns**	**28**	Includes all conditions in duplicate