

*AMMTEC* CONSULTING, INC.

*SYNTHETIC FIBER REINFORCED  
SHOTCRETE SWIMMING POOL DESIGN*

**PRESENTATION  
TO**



**WEDNESDAY, AUGUST 17, 2005, 2:00PM**

# BACKGROUND

- **Rising steel costs**
- **Requests from industry for steel alternative**
- **Research of structural fiber options**



- **Polyethylene/Polypropylene**
- **Euclid Chemical Co.- Under Brand Name**

**AQUAFIBER**

- 
- **Pima County**
  - **AMMTEC**
  - **Patio Pools**
  - **Tucson Ready Mix**
  - **Anthony & Sylvan Pools**

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# Simulated Pool Shell



# Tucson Spool



- 30' X 15' X 5'
- Carved Rock Waterfall

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# Tucson Pool



- 30' X 20' X 6'
- Carved Rock Waterfall



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# Pahrump Pool

35' X 22' X 8'

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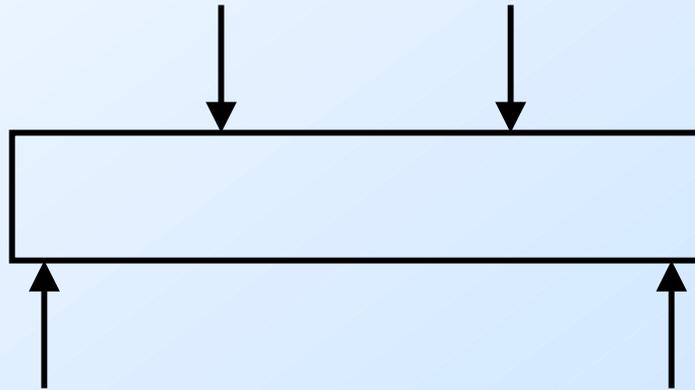


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# Development & Testing Procedures

Development of plan using design criteria  
based on testing results



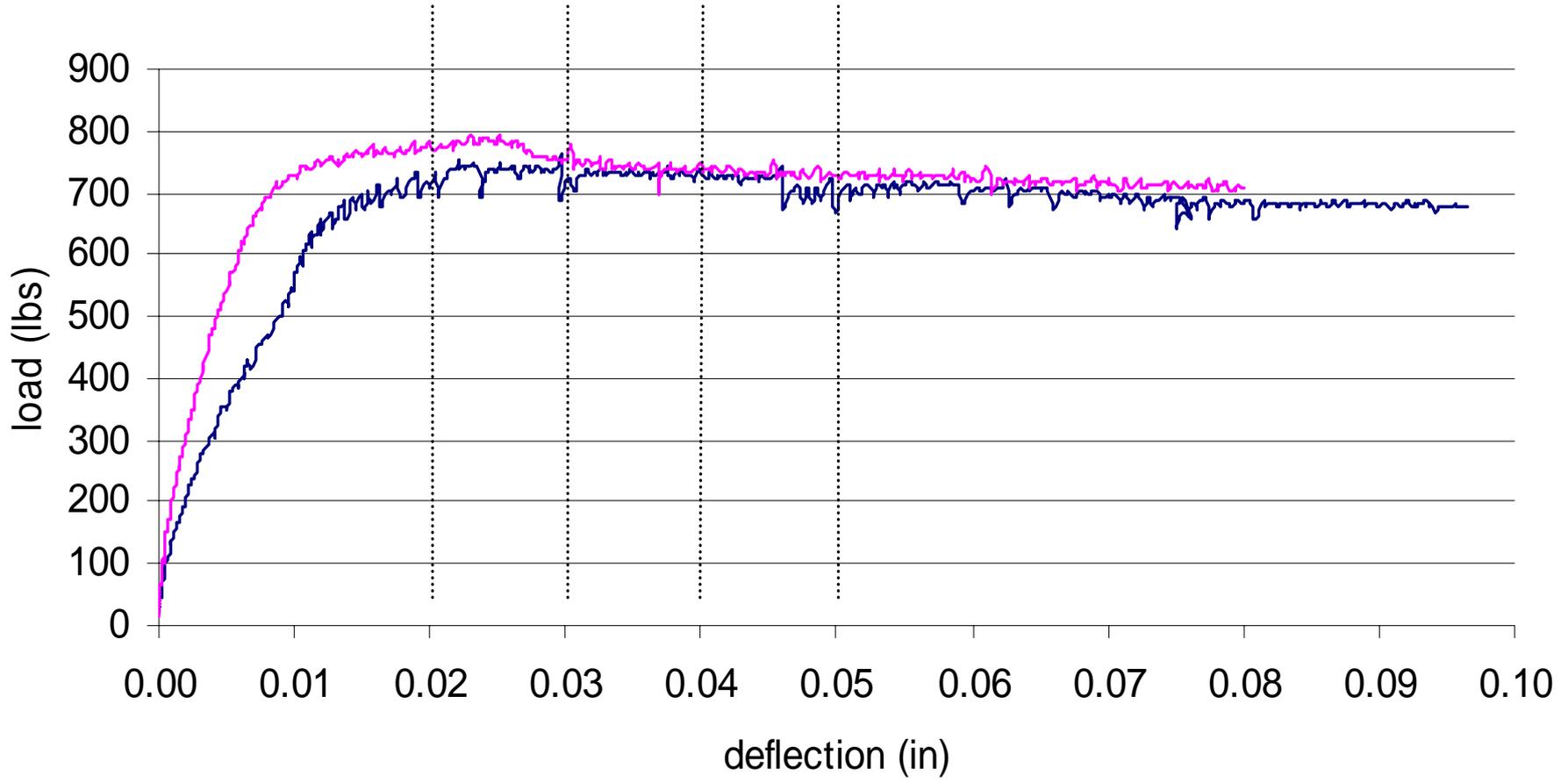


# ASTM 1399 LABORATORY FLEXURAL BEAM TESTING

- 4" X 4" 16"
- Shipped to MacTec, Atlanta
- Test results confirmed Dalhousie results

**ASTM C 1399 Load Deflection Curves**

— beam 1 — beam 2



Residual Strength Index calculated as average post crack capacity (stress)  
at 0.02, 0.03, 0.04 & 0.05 in deflection – normalized to account for sample sizes

Beam 1=133 psi, beam 2=143 psi

# Basis of Fiber Reinforced Flexural Concrete Design

## Various Moment Capacities / Strength Method:

$f_c$  (psi), minimum compressive strength of shotcrete = 2,500 psi

$\sigma_F$  (psi), tensile stress of fiber reinforced concrete section (varies based on fiber dosage per cubic yard).  $\sigma_F$  applied for calculation of moment capacity of pool section is based on the minimum average strength of AquaFiber reinforced concrete beams derived from analysis of samples collected during the construction of four trial pools constructed in southern Arizona and Nevada. All pools were constructed using an AquaFiber dosage rate of six (6) pounds per cubic yard of shotcrete. Beam samples were submitted to three independent accredited laboratories and tested in accordance with ASTM C 1399 and/or ASTM C 1018. This analysis yielded a minimum post-crack average residual strength of the AquaFiber reinforced sections of 80 psi.

$$\text{Equation: } M_A = M_n / 1.7 = [(\sigma_F * I) / (12 * c)] / (1.7)$$

Where:  $M_n$  (ft-lbs), nominal flexural strength of pool section

$M_A$  (ft-lbs), allowable moment under factored loads =  $M_n / (1.7)$  for soil

$\sigma_F = 80$  (psi) {Based on laboratory testing at 6 lbs per cubic yard}

$I =$  Gross moment of inertia of section =  $b * t^3 / 3$

12 (inches) = unit width of analysis section

$t$  (inches) = thickness of pool section

$c$  (inches) = depth to centroid of section ( $t/2$ )

1.7 Strength reduction load factor for soil

$V_n$  (lbs), nominal shear strength =  $2 * \sqrt{f'c} * (b) * (d)$

$\phi$  (shear strength capacity reduction factor) = 0.85

$V$  (lbs), allowable shear force, under factored loads =  $(V_n \phi) / 1.7$ , for soil

Aqua Fiber Gunite Thickness Requirements												Standard Detail: 8C					
Depth of Pool Section (ft):			8.0 feet			Soil Type: C			Expansive Soil w/ Slope			Pool Cove Radius (ft): 3.0					
RESISTING MOMENT												MOMENT FROM SOIL					
Pool Wall Radius (ft.) = 3.0						Depth to Radius (ft.) = 5.0						EFP = 60					
h(ft.)	t(in.)	Vp	Vt	Vs	xc	xms	L	Wts	Wtst	Ms	xmc	Mr	h(ft.)	Ms	Vs		
1.0	6.00	0.00	0.00	0.00	3.25	0.00	1.00	70	70	0	0.00	0	1.0	10	30		
2.0	6.00	0.00	0.00	0.00	3.25	0.00	1.00	70	140	0	0.00	0	2.0	80	120		
3.0	6.00	0.00	0.00	0.00	3.25	0.00	1.00	70	210	0	0.00	0	3.0	270	270		
3.5	6.00	0.00	0.00	0.00	3.25	0.00	0.50	35	245	0	0.00	0	3.5	429	368		
4.0	6.00	0.00	0.00	0.00	3.25	0.00	0.50	35	280	0	0.00	0	4.0	640	480		
4.5	6.00	0.00	0.00	0.00	3.25	0.00	0.50	35	315	0	0.00	0	4.5	911	608		
5.0	6.00	0.00	0.00	0.00	3.25	0.00	0.50	35	350	0	0.00	0	5.0	1250	750		
5.5	7.00	0.17	0.00	0.17	3.25	0.03	0.55	45	395	2	0.00	3	5.5	1664	908		
6.0	8.00	0.34	0.17	0.17	3.14	0.08	0.57	54	449	5	0.10	54	6.0	2160	1080		
6.5	9.00	0.52	0.34	0.18	2.92	0.14	0.62	65	514	9	0.22	176	6.5	2746	1268		
7.0	10.00	0.73	0.52	0.21	2.55	0.22	0.70	82	596	18	0.38	419	7.0	3430	1470		
7.5	10.00	0.99	0.73	0.26	1.89	0.35	0.87	102	698	35	0.66	913	7.5	4219	1688		
8.0	11.00	1.57	0.99	0.59	0.00	1.00	2.03	260	958	260	1.89	2981	8.0	5120	1920		
8.5													8.5	6141	2168		
9.0													9.0	7290	2430		
9.5													9.5	8574	2708		
10.0													10.0	10000	3000		
10.5													10.5	11576	3308		
11.0													11.0	13310	3630		
11.5													11.5	15209	3968		
12.0													12.0	17280	4320		
12.5													12.5	19531	4688		
13.0													13.0	21970	5070		

Resulting Design Moment	Moment Capacity of Construction						Where: $M_A = [(\sigma^2 I) / (12 * c)] / 1.7 = (ft^4 * lbs)$	
	EFP = 60	psf	Shotcrete	c	$\sigma$	'I'		$M_A$
h(ft.)	$M_{RD} = M_S - M_R$		(ft) in.	in.	psi	in. <sup>4</sup>	ft-lb	ft-lb
1.0	10		6	3.00	80	864	1129	1119
2.0	80		6	3.00	80	864	1129	1049
3.0	270		6	3.00	80	864	1129	859
3.5	429		6	3.00	80	864	1129	701
4.0	640		6	3.00	80	864	1129	489
4.5	911		6	3.00	80	864	1129	218
5.0	1250		7	3.50	80	1372	1537	287
5.5	1660		8	4.00	80	2048	2008	347
6.0	2106		9	4.50	80	2916	2541	435
6.5	2570		10	5.00	80	4000	3137	567
7.0	3011		10	5.00	80	4000	3137	126
7.5	3306		11	5.50	80	5324	3796	490
8.0	2139		11	5.50	80	5324	3796	1657
8.5								
9.0								
9.5								
10.0								
10.5								
11.0								

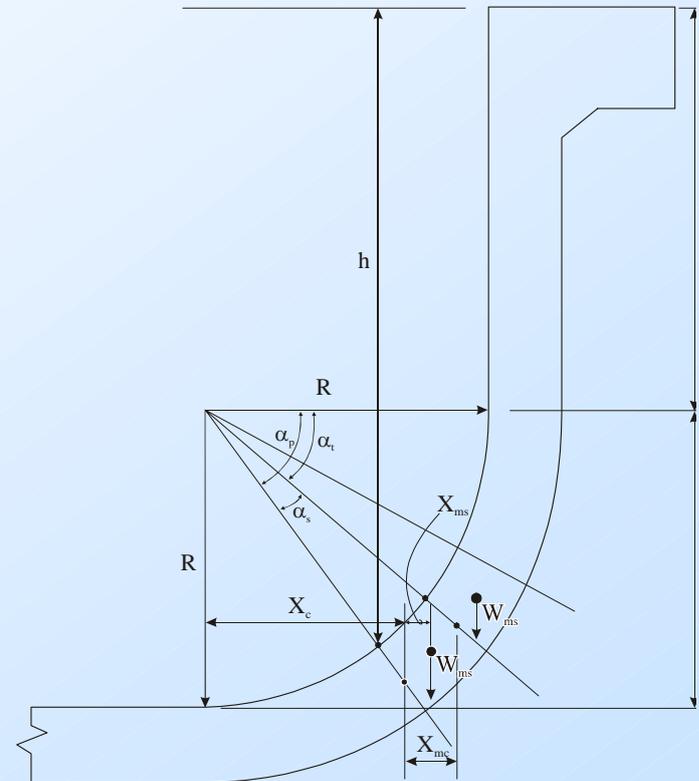
  

		PROJECT: AquaFiber Reinforced	
		Standard Pool Plan Calculations	
		Plan IBC 2003 Compliant	
		COPYRIGHT © 2005 AMMTEC Consulting, Inc.	
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# CONSERVATIVE ASSUMPTIONS OF POOL DESIGN

- Pool shells are in general – closed, continuous, arched structures
- Design assumes pool shell is always empty resisting active soil pressures

Resisting Moment of Pool Wall and Radius – Diagram



# Application and Acceptance Under Current International Building Code

2000 and 2003 IBC Section 1909 and ACI 318 Chapter 22 allow permitting and approval for structural plain concrete (i.e., *structural concrete with no reinforcement or with less reinforcement than the minimum amount specified for reinforced concrete*) limited to:

1. Members that are continuously supported by soil or supported by other structural members capable of providing continuous vertical support; **or**
2. Member for which arch action provides compression under all conditions of loading; **or**
3. Walls and pedestals.



A photograph of a backyard swimming pool featuring a multi-tiered waterfall cascading over large, natural-looking rocks. The pool is surrounded by lush greenery, including palm trees and other tropical plants. The water in the pool is clear and blue. The overall scene is bright and sunny, suggesting a warm climate.

# Advantages to Aquafiber Reinforced Pools

- Reduced cost of construction
- No rust stains
- Reduces time of pool construction
- Material mix quality easily verified throughout batch tickets
- Increased ease of placement