Concrete Material Requirements for UTW

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What is UTWT?

•Ultra-Thin Whitetopping (UTWT) is a concrete overlay with a concrete pavement thickness between 3 to 5 inches.

•Usually placed over an existing asphalt pavement as a pavement rehabilitation.

•Requires smaller slabs for load and curling stress reduction.

Pictures from University Parking Lot E-15 (Southeast corner of 4th and Pennsylvania in Champaign)

Field Projects

•A study has been done of 5 existing pavements throughout Illinois of UTWT pavements.

•The table below shows each pavement mixture design, the recorded field strengths, and the latest survey of cracking information.

•Anna and Tuscola have the most field distresses and at an early ages. This may because it has a higher cement content which usually leads to more shrinkage or lower toughness.

•Piatt and Cumberland have lower cement contents and less distresses.

lb/yd3 @ SSD					
Mix	**1 (Cement plus Fly Ash) with and w/o fibers**	**2 High early strength concrete**	**3 High early strength concrete-district 5**	**4 lower cement content**	**5 try this for low cement and local**
Location	Schanck Avenue	Int. of Vienna and Main Streets	US Hwy 36	Cumberland County Highway 2	Piatt County Highway 4
District	District 1, Mundelein	District 9, Anna	District 5, Tuscola	District 5, Toledo	District 5, Monticello
Coarse Agg	1972	1805	1704	1836	1957
Fine Agg	1001	1008	1035	1256	1220
Cement	515	755	755	575	534
Water	267	273	255	197	179
Fly Ash C	140	0	0	0	0
Strux Fibers	4	0	0	0	0
AEA	Daravair 1400	Daravair 1400	Daravair 1400	Daravair 1400	Daravair 1400
Other admix	WRDA 82	Daracem 65	Daracem 65	Daratard 17	Daracem 65
Strengths					
7 day Compressive Strength (psi)	3516	3553	-	-	-
14 day Flexural Strength (psi)	-	-	917	891	934
Distresses					
Time of Survey (yrs)	-	3.3	5	0.7	3.6
% Corner-Break Slabs	-	14.63%	3.02%	0.00%	0.20%
%Transverse Cracks	-	3.66%	1.04%	0.42%	0.30%
%Longitudinal Cracks	-	3.14%	0.31%	0.00%	0.00%
% Debonded Slabs	-	2.00%	2.04%	0.00%	0.00%

Anna – rutting in AC

Anna – whitetopping distresses

Laboratory Experiments

•An in-depth study of the field mixture design properties for each pavement is currently underway.

•The table below shows hardened properties: strength, modulus and toughness measurements at 14 days and fresh properties of 3 mixtures already tested.

•Age tests are currently being carried out at 7, 28, and 90 days for various mixtures.

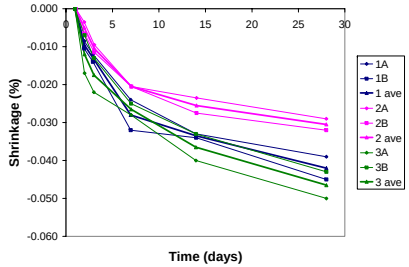
		Mix 1 no fiber, fly ash	Mix 2 fiber, fly ash	Mix 3 high cement
Location	unit	Schanck Ave	Schanck Ave	Anna
Compressive Strength f_c	psi	3,283	5,054	4,905
Split Tensile Strength f_t	psi	332	553	579
Elastic Modulus E	ksi	3,276	4,565	4,451
Unit Weight	kg/m^3	2,150	2,287	2,345
Air Content	%	10.3	5.3	4.6
Slump	in	5.00	4.75	3.25

Shrinkage

•All specimens were demolded after 24 hr. and kept in a room at 50% RH, 20°C.

•Mix 2 (Fiber) showed the lowest shrinkage at every age.

•Mix 3 (High Cement) has greatest shrinkage as predicted.



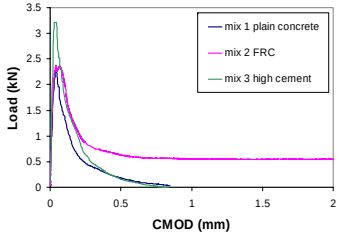
Fracture Toughness Testing at 14 days

•Beams of dimension 150x700x80mm were notched at mid-span and tested under 3-pt bending.

•Testing was performed according to the Two Parameter Fracture Model *(Jenq & Shah 1985)*

•Mix 2 (Fiber) demonstrated a high total fracture energy.

•Mix 3 (High Cement) had a slightly higher peak load and stress intensity factor.



	Initial Fracture					Total Fracture
Mixture	P_c (kN)	E (GPa)	K_{Ic} (MPa m$^{1/2}$)	$CTOD_c$ (mm)	G_{Ic} (N/m)	G_F (N/m)
Mix 1	2.4	17.1	0.856	0.0314	43.7	49
Mix 2	2.3	19.8	0.817	0.0249	33.8	994
Mix 3	3.7	26.3	0.997	0.0138	39.7	81

Composite Beam Testing at 14 days

•Simulate pavement structure: 3" of UTW over 3" cracked asphalt over clay subgrade.

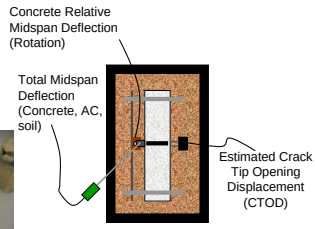
•Determine composite vertical deflections of entire structure under loading.

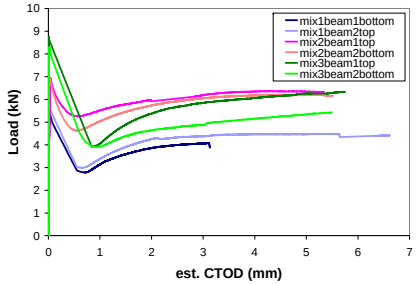
•Simulate reflective cracking by measuring an crack opening displacements.

•FRC (mix 2) has greater est. CTOD, smaller deflections and a smaller drop in loading after fracture

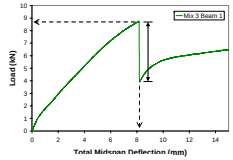
•High Cement (mix 3) has greatest peak and greatest loading drop after fracture

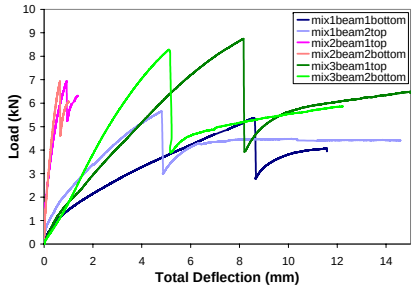
Soil preparation for composite beam tests





Mixture	Peak Load (kN)	est. CTOD (mm)	Deflection at Peak (mm)	% Drop
Mix 1	5.52	0.0163	6.70	47.74
Mix 2	6.93	0.0269	0.79	28.83
Mix 3	8.52	0.0105	6.58	54.10





Modulus of Rupture (Flexure) at 14 days

		Mix 1 no fiber, fly ash	Mix 2 fiber, fly ash	Mix 3 high cement
Location	unit	Schanck Ave	Schanck Ave	Anna
Flexural Strength MOR	psi	358	456	569
Residual Strength f_{e3}	psi	16	92	24
Residual Strength Ratio R_{e3}	%	4.4	20.2	4.2