Table 7 Transmission Length Results

Steel	End Reinf.	Concrete Properties: Strength N/mm^2	Concrete Properties: Applied Stress N/mm^2	Concrete Properties: Stress/Strength %	Steel Stress/Strength %	Transmission Length at transfer, diam.: Range	Transmission Length at transfer, diam.: Mean
Granite Aggregate Concrete - HAC							
7mm, indented	none	82-95	35-36	37-42	61-63	44-71	60*
7mm, indented	none	82-95	35-36	37-42	61-63	91-134	105+
12.7mm, strand	stirrups or stirrups + helix	82-97	32-26	33-40	71-78	49-59	55*
12.7mm, strand	stirrups or stirrups + helix	82-97	32-36	33-40	71-78	56-92	71+
Granite Aggregate Concrete - UFPC							
7mm, indented	none	69	27	39	64	38-65	-
12.7mm, strand	stirrups + helix	79	28	36	62	24-42	-
Lightweight Aggregate Concrete - UFPC							
7mm, indented	none	43-47	14-15	32-34	70	87-102*	-
7mm, indented	none	43-47	14-15	32-34	70	94-120+	
12.7mm, strand	none	42-43	15	34-35	60	34-60*	-
12.7mm, strand	none	42-43	15	34-35	60	64-82+	-

* Dead end; + Cut end; Age at transfer: HAC 1-7 days; UFPC 7 days
28 day strength: HAC 100 - 110 N/mm^2; UFPC (Granite) 70 - 80 N/mm^2
UFPC (Lightweight agg.) 48 - 50 N/mm^2

Table 8 Prestress Losses in UFPC Concrete with Granite Aggregates

Cement	Concrete Properties			Steel	Prestress losses %				Specific Creep*
	Strength N/mm^2	Stress N/mm^2	$\frac{\text{Stress}}{\text{Strength}}$ %	$\frac{\text{Stress}}{\text{Strength}}$ %	Shrinkage	Creep	Steel	Total	
HAC	100.6	34.2	34	64	2.1	23.4	4.2	29.1	29.8
HAC	103.3	41.5	40	61	2.0	31.2	3.5	36.7	32.9
UFPC	79.3	30.6	39	56	12.0	30.3	3.0	45.3	42.0

Age at transfer 28 days

* x 10^{-6} m/m per N/mm^2

Table 9 Prestress Losses in UFPC Concrete with Lightweight Aggregates

Steel properties			Initial strain	Post-tensioned concrete						Pre-tensioned concrete					
Type and diameter	Ultimate stress	Initial pre-tension		For a final concrete stress of						For a final concrete stress of					
				10.4 N/mm²		13.8 N/mm²		17.3 N/mm²		10.4 N/mm²		13.8 N/mm²		17.3 N/mm²	
				Initial stress	Per cent loss	Initial stress	Per cent loss	Initial stress	Per cent loss	Initial stress	Per cent loss	Initial stress	Per cent loss	Initial stress	Per cent loss
(mm)	(N/mm²)	(N/mm²)	(x 10³)												
						According to beam results									
Macalloy 19 and 25	970	690	3.9	15.6	33.6	23.5	41.5	34.0	49.5	-	-	-	-	-	-
Wires 7	1570	1100	515	13.7	24.5	19.6	29.5	26.5	35.0	17.3	40.0	27.6	50.0	40.0	57.0
Strands 12.7	1860	1310	6.55	13.0	20.0	17.4	25.0	24.6	29.7	15.2	32.0	23.5	42.0	35.5	51.5
						According to prisms results									
Macalloy 19 and 25	970	690	3.9	19.5	47.0	33.0	58.0	-x	-	-	-	-	-	-	-
Wires 7	1570	1100	5.5	15.2	33.0	23.4	41.0	34.0	49.5	20.8	50.0	40.5	66.0	-x	-x
Strands 12.7	1866	1310	6.55	14.4	28.0	21.1	34.7	29.8	42.0	17.6	41.0	30.0	54.0	-x	-x

N.B. Initial steel stress is taken as 70% of the ultimate stress.
Modulus of elasticity has taken as: For concrete 18.000 N/mm²
For Macalloy 176.000 N/mm²
For wires and strands 200.00 N/mm²

For relaxation losses add:
3 - 4% for Macalloy bars
3% for wires and strands
x Initial stress would be 52.0 N/mm² or more

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Table 10 Details of Long Term Tests

Beam Mark	Concrete Mix	Details of Reinforcement: Type and No.	Details of Reinforcement: Steel Area (mm^2)	Beam Size (mm): Width	Beam Size (mm): Effective Depth	Age at Loading (Days)	Cube Strength (N/mm^2)	Modulus of Elasticity kN/mm^2	Design Moment Nm 1	Working Moment Nm 2	Ratio $\frac{\text{Col. 1}}{\text{Col. 2}}$
				Reinforced Beams							
L1	HAC	6 - 14mm ϕ Bristrands	615	127	151	19	98.7	49.9	24332	24338	1.00
L2	HAC	4 - 19mm ϕ Deformed Bars	1140	127	149	19	101.5	49.8	24318	24645	1.01
L3	UFPC	6 - 14mm ϕ Bristrands	615	127	151	32	86.5	39.0	19908	18264	0.92
L4	UFPC	4 - 19mm ϕ Deformed Bars	1140	127	149	32	89.6	40.9	19313	18570	0.96
				Prestressed Beams							
L5	UFPC	2 - 12.7mm ϕ Dyform Strands	224	102	140	27	89.0	36.3	19323	19634	1.02
L6	UFPC	8 - 7mm ϕ Bridon Wires	308	102	140	27	84.1	36.1	19323	19900	1.03
L7	HAC	2 - 12.7mm ϕ Dyform Strands	224	102	140	15	95.0	48.8	24153	21293	0.88
L8	HAC	8 - 7mm ϕ Bridon Wires	308	102	140	15	100.5	49.2	24153	21560	0.89

Table 11 Deflection Behavior Under Sustained Load

Beam	Measured defl. δ mm		$\frac{\delta\ 1\ yr}{\delta_i}$	$\frac{span}{defln}$ 1 yr	δ calc* at 1 yr	$\frac{\delta\ calc}{\delta\ 1\ yr}$	Ultimate Defl. mm		
	Instant	1 yr					Method+1	Method**2	Method++3
				Reinforced Beams					
L1	8.70	18.36	2.10	125	13.77	0.75	2.32	2.72	2.79
L2	6.29	11.43	1.82	200	9.80	0.86	2.50	2.83	2.80
L3	6.00	13.84	2.30	165	12.42	0.90	2.82	2.88	3.21
L4	5.13	10.62	2.07	215	9.10	0.86	2.53	2.44	2.64
				Prestressed Beams					
L5	5.33	14.70	2.75	156	11.33	0.77	3.25	2.84	2.79
L6	5.40	13.71	2.54	167	10.92	0.80	3.12	2.86	2.83
L7	5.05	14.73	2.92	155	7.91	0.54	3.25	3.14	3.07
L8	3.63	7.11	1.96	322	7.16	1.01	2.07	2.85	2.85

* Calculated deflections based on (1) curvature*, (2) hyperbolic model+, (3) BS code** and ACI Code++

Table 12 Creep Effects Under Sustained Loading

Beam	One year data		Ultimate Creep		Increase in neutral axis depth %
	creep strain x 10^{-6} m/m	creep coefficient	creep strain x 10^{-6} m/m	creep coefficient	
L1			Reinforced Beams		
L1	1623	1.54	2773	2.63	37
L2	1397	1.62	3417	3.97	34
L3	1275	1.67	1937	2.55	37
L4	1115	1.79	1730	2.79	37
			Prestressed Beams		
L5	1993	2.21	2727	3.03	16
L6	2313	2.72	2867	3.37	17
L7	1893	2.52	2365	3.15	19
L8	1383	2.00	2187	3.17	20

Table 13 Cracking Behaviour Under Sustained Loading

Beam	Age days	Maximum crack width x 10^2 mm			
		Instantaneous		Time-dependent	
		Steel level	Tension Face	Steel level	Tension Face
			Reinforced Beams		
L1	435	15	38	15	40
L2	435	7.6	18	9	25
L3	405	7.6	18	15	33
L4	405	5.4	8	7.6	7.6
			Prestressed Beams		
L5	380	2.5	10	2.5	15
L6	390	5	10	5	17.8
L7	375	7	33	10	38
L8	375	-	-	-	-

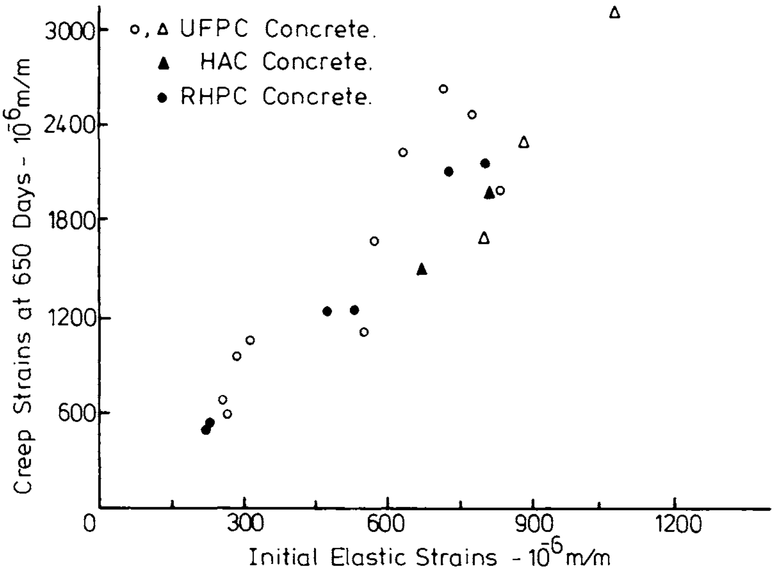

Fig. 1--Relation between creep strain at 650 days and initial elastic strain on loading

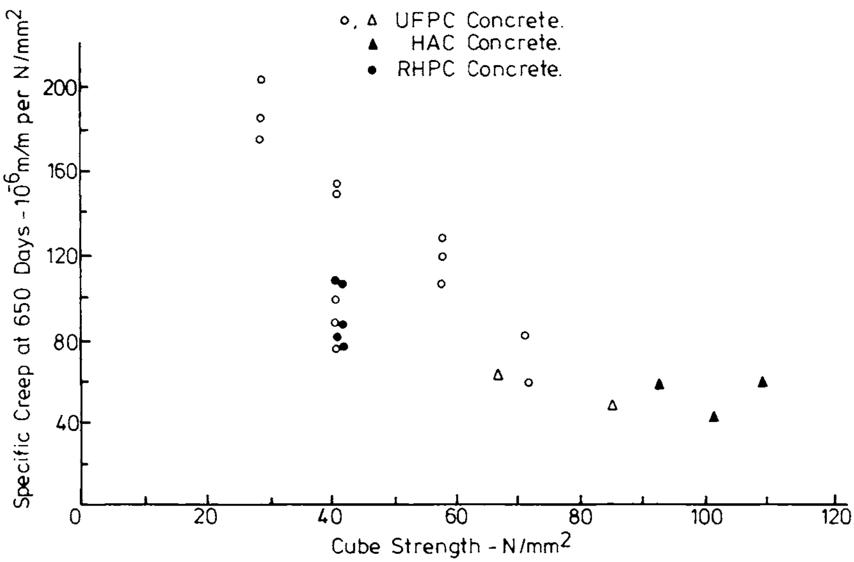

Fig. 2--Influence of concrete strength at loading on specific creep at 650 days

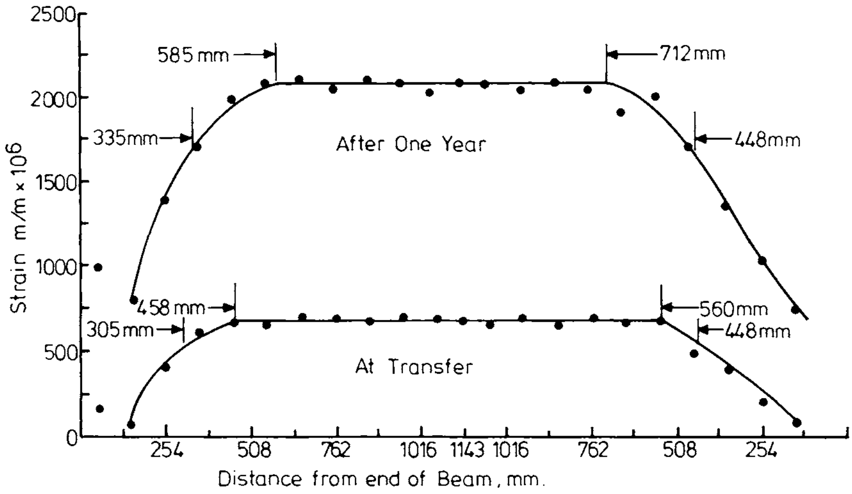

Fig. 3--Transmission length of 12.7mm diameter strands in pre-stressed lightweight concrete beams (UFPC)

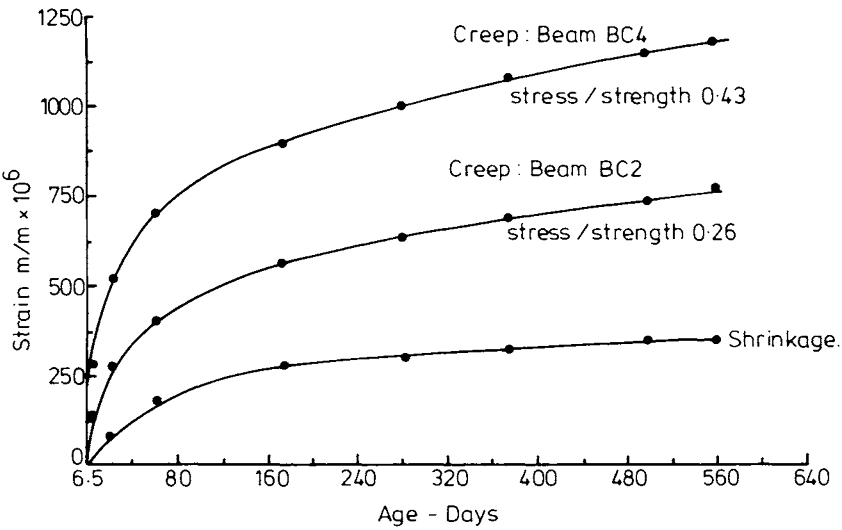

Fig. 4--Shrinkage and creep behaviour of post-tensioned pre-stressed beams (UFPC: lightweight aggregates)

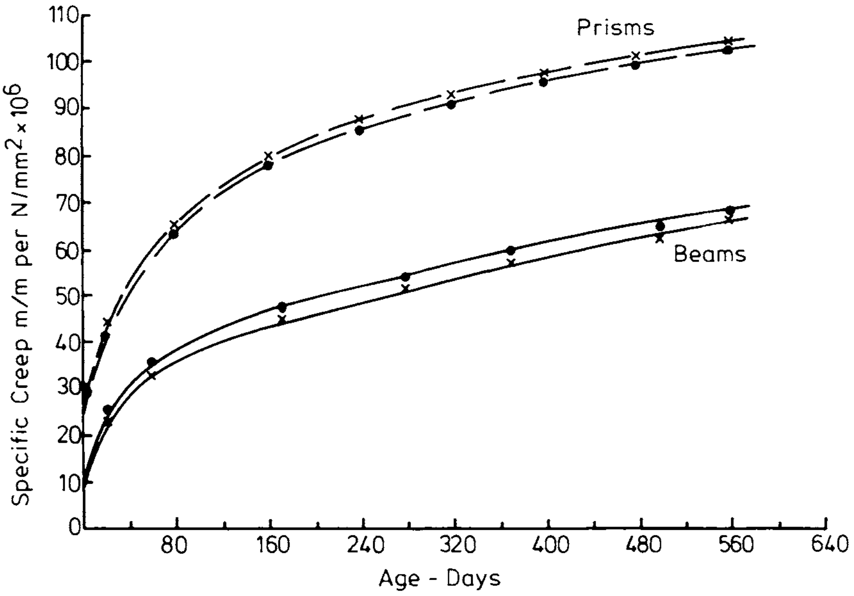

Fig. 5--Comparion of specific creep behaviour of post-tensioned beams and plain concrete prisms (UFPC: lightweight aggregates)

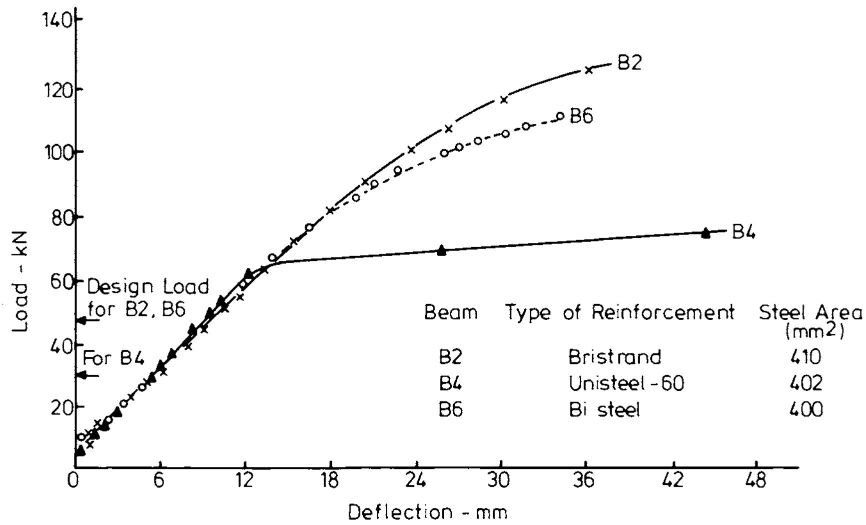

Fig. 6--Load deflection behaviour of beams reinforced with equal amounts of three different types of reinforcing steels

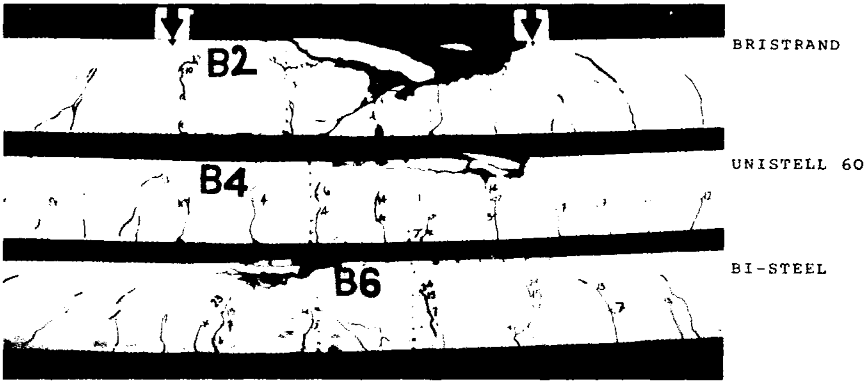

Fig. 7--Failure characteristics of high-strength reinforced concrete beams containing three different grades of steel: top (bristrand), middle (deformed bars), bottom (bi-steel)