

ROLE OF MINERAL AMITURES IN PAVEMENT QUALITY CONCRETE

By

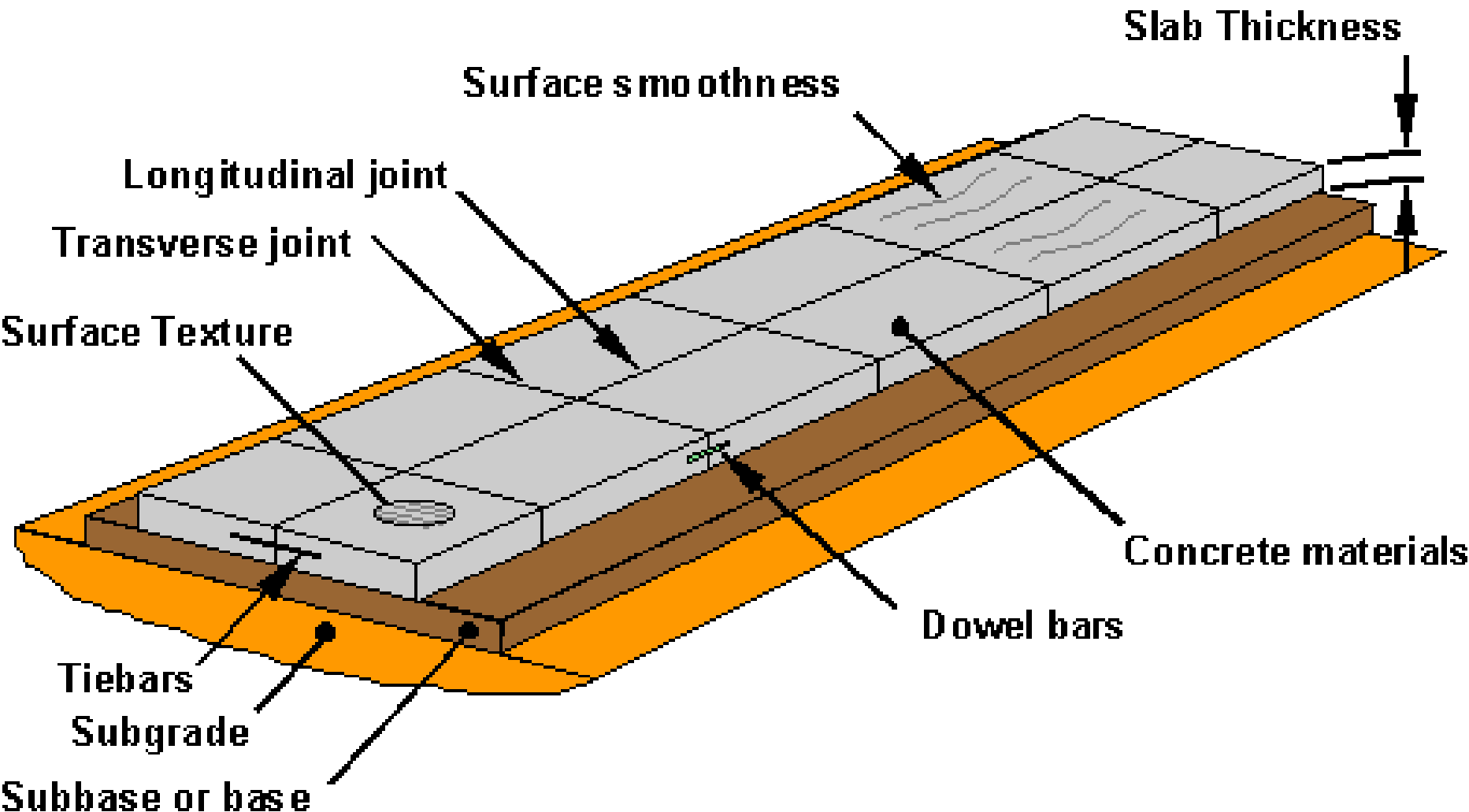
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Concrete Pavement - Basic Components



PQC REQUIREMENTS

- ✦ **Structural & Functional Performance**
- ✦ **Concrete Flexural Strength: 4.0- 4.5 MPa
(M35 - M40 Grade)**
- ✦ **Slump: 20-25 mm(paver), 40-45 mm(manual)**
- ✦ **Cement content: 450 kg/m³ max.**
- ✦ **Water-CM Ratio : 0.35 – 0.40**
- ✦ **Use of Superplasticisers**
- ✦ **Use of Mineral Admixtures (Slag & Fly ash)**

Typical Composition Fly Ash Vs Coal Type

Component	Coal Type		
	Bituminous	Sub-Bituminous	Lignite
SiO_2	20 - 60	40 - -60	15 - -45
Al_2O_3	5 - 35	20 - 30	10 - 25
Fe_2O_3	10 - 40	4 - 10	4 - 15
CaO	1 - 12	5 - 30	15 - 40
MgO	0 - 5	1 - 6	3 - 10
SO_3	0 - 4	0 - 2	0 - 10
Na_2O	0 - 4	0 - 2	0 - 6
K_2O	0 - 3	0 - 4	0 - 4
LOI	0 - 15	0 - 3	0 - 5

TYPICAL COMPOSITION OF GGBFS

Sr. No.	Constituent	Content, % by Mass	Requirements as per IS:12089-1987
1	Silica (SiO ₂)	34.2	-
2	Alumina (Al ₂ O ₃)	17.5	-
3	Calcium Oxide (CaO)	35.0	-
4	Iron Oxide (Fe ₂ O ₃)	0.74	-
5	Magnesia (MgO)	10.1	Max 17%
6	Sulphide as Sulphur	0.42	Max 2.0%
7	Manganese Oxide	0.12	Max 5.5%
8	(CaO + MgO + Al ₂ O ₃) / SiO ₂	1.83	≥ 1.0
9	Glass Content	96	≥ 85 %

How Fly Ash Works?

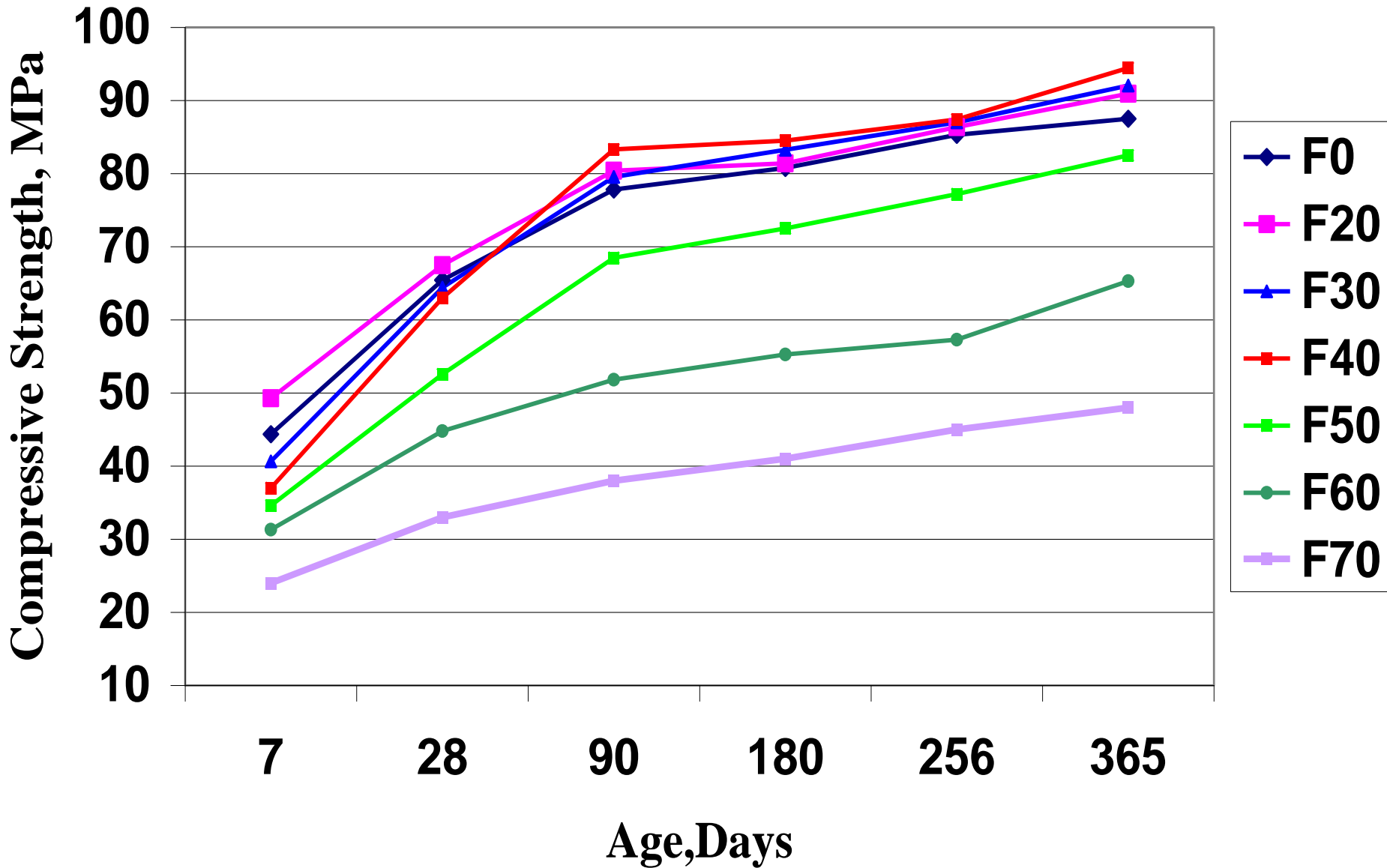


Additional C-S-H gel

PQC MIX PROPORTIONS

Mix Designation	MA Replacement Level, %	Cement (kg/m ³)	MA (kg/m ³)	Sand (kg/m ³)	10 mm (kg/m ³)	20 mm (kg/m ³)	Water (kg/m ³)
S0	0	400	0	724.626	344.711	805.454	166.00
S10	10	360	40	723.801	344.292	804.744	166.00
S20	20	320	80	722.936	343.873	803.495	165.994
S30	30	280	120	722.00	341.46	802.54	165.987
S40	40	240	160	721.197	343.051	801.575	165.997
S50	50	200	200	720.32	342.636	800.60	165.97
S60	60	160	240	719.448	342.221	799.636	165.965

Development of Compressive Strength at 0.30 w/cm



TYPICAL COMPRESSIVE STRENGTH WITH GGBFS

Mix Designation	Compressive Strength, (N/mm ²)		
	7 Days	28 Days	90 Days
S0	31.15	45.20	55.88
S10	32.85	48.43	57.93
S20	45.39	53.80	58.59
S30	33.02	49.78	59.47
S40	32.85	45.78	61.00
S50	31.20	45.00	56.23
S60	30.48	37.59	46.65

TYPICAL FLEXURAL STRENGTH (GGBFS)

Mix Designation	Flexural Strength, (N/mm ²)		
	7 Days	28 Days	90 Days
S0	3.5	5.4	5.8
S10	3.7	5.3	6.2
S20	4.3	5.7	6.6
S30	4.1	5.6	6.7
S40	3.9	5.5	6.9
S50	3.6	5.3	5.8
S60	3.0	4.0	4.9

FLEXURAL STRENGTH, PQC THICKNESS AND COST SAVING

Mix Designation	90 D Flexural Strength, (N/mm ²)	PQC Thickness, mm	Cost Saving (2Lane/km)	
			Cement @ Rs5/kg, (Lakh Rs.)	PQC @ Rs7000/CM, (Lakh Rs.)
S0	5.8	250	-	-
S10	6.2	240	4.08	5.95
S20	6.6	230	7.82	11.9
S30	6.7	225	11.47	14.87
S40	6.9	220	14.96	17.85
S50	5.8	250	21.25	Nil
S60	4.9			

At S40 Level 120 km road can be constructed in the cost of 100 km

PLASTIC SHRINKAGE CRACKING AND ROLE OF GGBFS



CAUSE OF PS CRACKING

- ✦ Rate of water evaporation from concrete surface is more than bleeding rate
 - ✦ High ambient temperature
 - ✦ High wind velocity
 - ✦ Low air humidity



Bleeding



PS Cracking

ECONOMIC MIX DESIGN WITH GGBFS

- ✦ Concrete of low water-cement ratio (<0.38) bleed less, so high probability of PS cracking
- ✦ For economic mix design with FA (cement saving) W/C is kept as low as 0.32
- ✦ Economical mix design possible with GGBFS without reducing w/c ratio, thus, avoiding PS cracking

CONCLUSIONS

- ✦ **Workability of concrete mixes do not change with the use of any amount of GGBFS. Use of suitable plasticiser can take care of the workability of the mix without changing the water requirement.**
- ✦ **Both short term (7 & 28 days) and long term (90 days) compressive as well as flexural strength of concrete is increased when cement is partially replaced by GGBFS up to a level of 40%. When 50 % cement is replaced by GGBFS, the strength of the concrete remains almost same.**

CONCLUSIONS

- ✦ **GGBFS can be used as partial replacement of OPC up to 50 % without compromising the requirement of short term and long term strength of PQC & PS cracking**

Thank You