CHAPTER 5

CONCLUSIONS

AND

FUTURE SCOPE
5.1 CONCLUSION

- Metakaoline is at par to Silicafume in contributing compressive strength and durability.
- Addition of metakaoline helps in reducing Rapid Chloride Permeability Test (RCPT) value. Its effect is superior compared to silicafume.
- Water demand for particular workability is lower as amount of activated fly ash increases i.e. for every 10% replacement of OPC by activated fly ash, there is 4% to 5% decreasing water demand (i.e. AFA played predominant role in improving the workability.)
- Workability (compaction factor) improves for multi component cement Type C to Type G, as %age of Activated fly ash increases (pozzolonic effect plays predominant role).
- Workable concrete with OPC< 300 Kg/m³ with pozzolonic materials helps to achieve 56 days compressive strength of 70-80 MPa with high durability (RCPT < 500 coulombs)
- Compressive strength decreases marginally for multi component cement from Type A to Type G.
- Split strength is not affected at all with the use of multi component cements. Use of mill scale helps to maintain the split strength.
- It is encouraging to note that the flexural strength is also maintained at par with OPC
- Stress-Strain characteristic on standard cylinders has indicated an adequate relationship between the compressive strength and Modulus of Elasticity (E). E values fall within the range prescribed for OPC.
• There is reduction in porosity from multi component cement Type A to Type G. As w/c ratio increases, Sorptivity, RCPT, Water absorption, Sulphate Resistance, Sea water Resistance and Chemical Resistance due to NaOH solution increases.

• Accelerated curing strength and Regression equations for multi component cement are as follows,

(1)\(Y=mX+C\) i.e. \(F56 = 1.228F_{acc} - 3.238\)

(2)\(Y=mX^2+C_1X +C_2\) i.e. \(F56 = -0.003F_{acc}^2 + 1.412F_{acc} + 1.018\)

Where \(Y=F56\) in N/mm\(^2\) and \(X=F_{acc}\) in N/mm\(^2\)

The model has stood successful for verification with respect to any type of pozzolonic multi component cements (Type B to Type G).

Above equations are very useful tool also for prediction of compressive strength at early age and helps for necessary corrections in mix proportions with various types of pozzolonic multi component cement concretes.

In case of OPC for M\(_{45}\) concrete, it is difficult to achieve RCPT value lower than 250 coulombs even for M\(_{25}\) & M\(_{20}\) concrete mix (Type E & Type F multi component blended cement). This shows that we can use 25% lower cover thickness than that of OPC for M\(_{45}\) concrete mix. Corrosion effect on steel is restricted in Type C and Type D multi blended cement concretes. As w/c ratio increases, rate of corrosion increases in all types of cement. Addition of Mk in OPC decreases rate of corrosion, as it helps to reduce w/c ratio without adverse effect on performance. On addition of AFA in MK based cement, corrosion resistance is enhanced. Considering equal w/c ratio, corrosion resistance in terms of life span increases by addition of MK in OPC.
by 10% to 40%. Addition of AFA in MK based cement enhances corrosion resistance in terms life span by 70% to 150%

- Due to addition of $Fe_2O_3$ in a system, sulphate resistance increases. This is confirmed by the experiments for $MgSO_4 + Na_2SO_4$.
- Multi Component Cement (MCC) plays prominent role with respect to reduction of green house gases and $CO_2$ emissions and cost factor attracts the attention for adopting Multi Component Cements.
- The use of mill scale, Metakaoline and Activated Fly Ash helps in reduction of OPC content from 12% to 62% from Multi Component Cement Type B to Type G.

**Considering all parameters like workability, strength, durability and economy, Type E Multi Component Cement stands on the top in selection for durability compared to other blends of cements.**

Typical composition of Type E Multi Component blended cement

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPC</td>
<td>58%</td>
</tr>
<tr>
<td>Activated Flyash</td>
<td>30%</td>
</tr>
<tr>
<td>Metakaoline</td>
<td>10%</td>
</tr>
<tr>
<td>Mill Scale</td>
<td>2%</td>
</tr>
</tbody>
</table>

- Unique concrete mix design procedure for Multi Component blended cements will be very helpful in any specific concrete mix design code.
- We can increase the production capacity of cement plant through the increased use of supplementary cementing materials or Multi Component blended cements concrete. This will help us to meet the
future demand of cement without installing the new plant. Capital cost/TPD (Ton per Day) will be lowered compared to OPC.

5.2 Future Scope

- There is a scope for further research to develop Self Compacting Concrete using Industrial Wastes and Byproducts and High volume ultrafine flyash with superpozzolona.
- Research is needed to study applicability of using blended superpozzolona (Metakaoline + Silica fume) for high strength and high durable concrete.
- Study on China clay (porcelain) waste can open new horizons in use of blended cement.
- High Alumina (Metakaoline, porcelain), High Iron (Millscale) cement can be the future entry in the blended cements.