

# **Practical R & D Innovations in Concrete Technology**

## **Part-1**

*By*

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*Sponsored by: ICI Bengaluru Centre*

*On*

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# 1.0 PREAMBLE :

## A) R & D Works

- (i) Considerable R & D is done by “ Masters” and Ph. D. students.
- (ii) Fortunately, there is a quantum leap in sponsored research at top IITs, both by Industry Sponsored and Research Funding. (Ref.: The Times of India, Mumbai Edition, Dated 10.10.2019)
- (iii) Still, unfortunately, simple practical innovations (R & D Works) are highly limited.

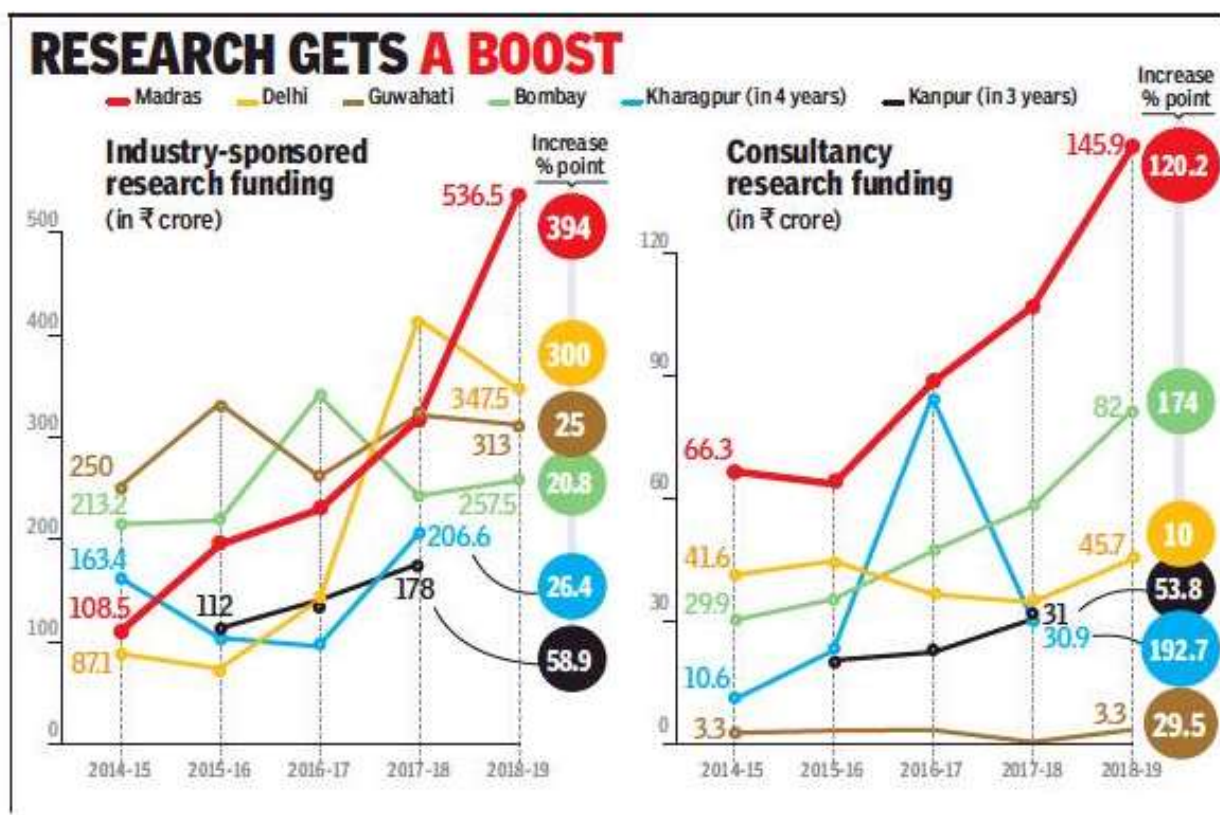


Fig.1

# 1.0 PREAMBLE :

## B) Global Innovative Index (GII)

We are unfortunately, even today close to bottom half of the Global Innovative Index. (GII)

Indians were known for Innovations.

- During Vedic Times.
- Even up to British Era.
- Went down substantially during British Era.
- But steadily Improving Now (Fig. 2). (Ref.:Times of India, Mumbai Edition Dated 11/07/2018)

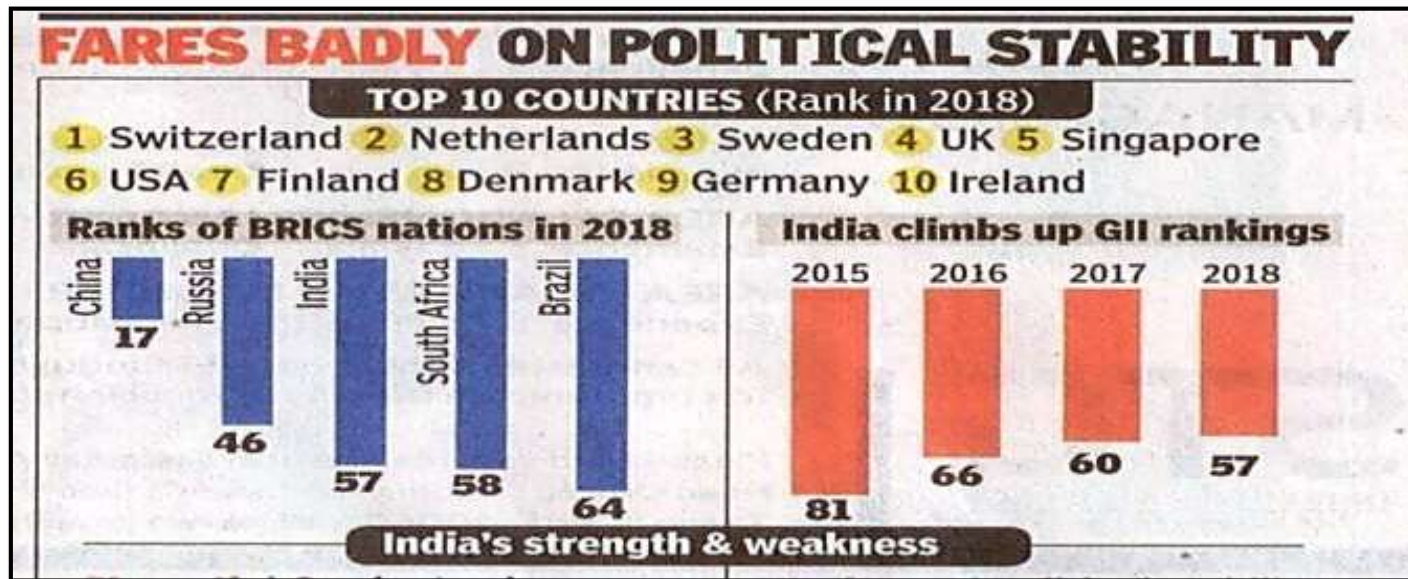


Fig.2

- **Thus in 2018, India was ranked 57 on Global Innovation Index (GII) (Out of 126 Countries).**
- **Up from Rank 81 in the year 2015.**
- **Out of Top 10 countries, 8 are from Europe.**
- **Singapore #5, USA number 6.**



Fig.3

## FIRST 10 COUNTRIES IN THE RANKING OF GLOBAL INNOVATION INDEX (2019)

**Table 1:**

S. No.	NAME OF THE COUNTRY	2019 Rank	2018 Rank
1	Switzerland	1	1
2	Sweden	2	3
3	United States of America	3	6
4	Netherlands	4	2
5	United Kingdom	5	4
6	Finland	6	7
7	Denmark	7	8
8	Singapore	8	5
9	Germany	9	9
10	Israel	10	11



In 2019, India has improved its ranking by making a progress of 5 positions. **In 2018, it was 57, now it is 52.** In the coming years, by 2025, India aspires to be in top 25 rankings.

(Source: The Times of India, July 25, 2019)

### ❖ **Shiva Temples in India:**

There are 7 temples almost on the same longitude. ( $79^{\circ} 41'54'' E$ ) They are spread from

Kedarnath to Rameswaram. Some of these temples were constructed before more than 4000 years. It is a miracle how these temples were located without the help of Google, GPS or even instruments like theodolite. (Fig. 4)



Fig.4

## 2.0 Typical Examples of Practical Innovations (R & D)

### 2.1 Cover to the Hopper etc. of Transit Mixer for Rain Protection :

Refer Fig. 5.

\*Both Hopper and Sides are covered.

\* Zero Water Entry in Rains.

Cover to prevent rain water  
entry through Hopper



Detachable Cover to prevent rain  
water entry from the sides in TM

Fig. 5



## 2.2 Importance of w/b Ratio:

As w/b ratio increases-

- Strength Decreases. (Refer Fig. 6)
- Durability Reduces.
- Hence, Sustainability Reduces.

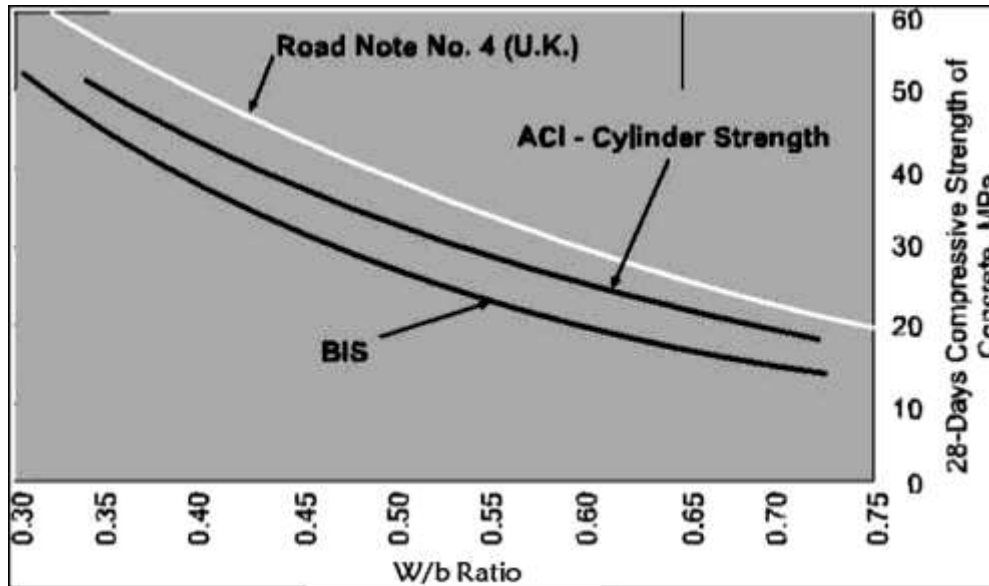


Fig. 6 : Generalized relationship between water binder ratio and compressive strength of concrete — lower the ratio higher is the strength.

Thus, w/b ratio increases from 0.35 to 0.65-

- Strength decreases to 37% (Reduction 63%).
- Permeability increases by 950 times.
- Hence Durability is Greatly Reduced.

Table 2

WBR	Compressive Strength (MPa)	Coefficient of Permeability (Valenta)
0.35	46	$1.05 \times 10^{-3}$
0.50	33	$10.3 \times 10^{-3}$
0.65	17	$1000 \times 10^{-3}$

$$46/17 = \frac{1}{0.37} \text{ at } w/b \text{ ratio of } 0.35 \text{ and } 0.65$$

$$1000/1.05 = 950 \text{ at } w/b \text{ ratio of } 0.35 \text{ and } 0.65$$

**Even with minor variations in water content, there is a significant effect on strength and durability, thus**

- **When w/b ratio increases from 0.4 to 0.42-**
- **Strength decreases by 6%.**
- **Permeability increases by 300%.**
- **Hence, Durability is Greatly Reduced.**

## 2.3 Chemical Admixture Protection :

- Should not be kept open in sun.
- Should be Vibrated and Stirred before use.
- Admixture Drum at the Batching Plant (Fig. 7).



Incorrect Method – Cap to be provided to arrest dust contaminating the chemical

Fig. 7(a)



Highly incorrect method of pumping admixture with drum lid cut open

Fig. 7(b)



Proper arrangement for covering the lid of drum to avoid contamination

Fig. 7(c)

- With Fig. 7(c), Vibration & Stirring is possible. (Video-1)
- How to use the desiccator? ( Video-2)



Video-1.mp4

## 2.4 Opening of the Cement Bags at the Batching Plant:

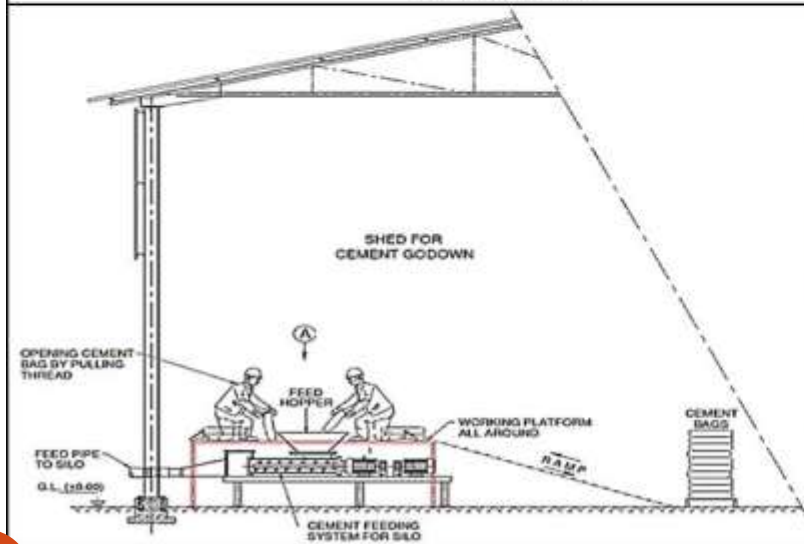
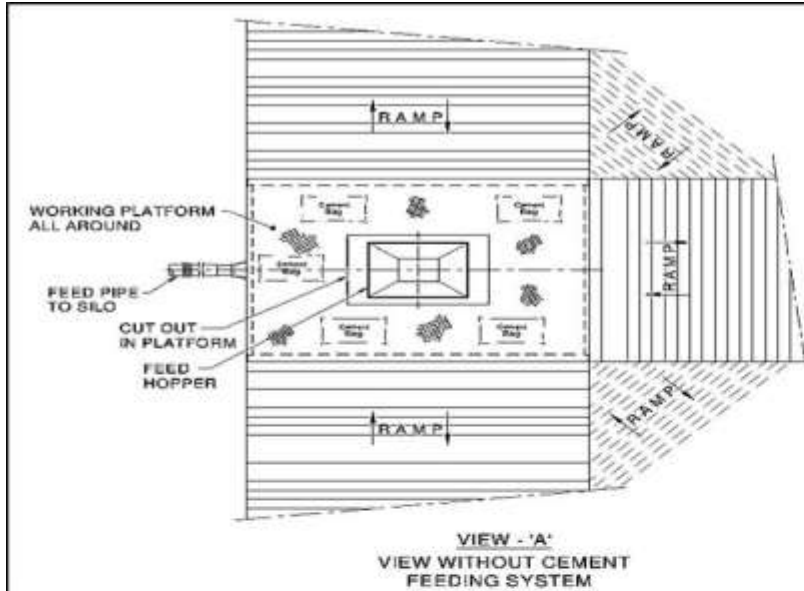
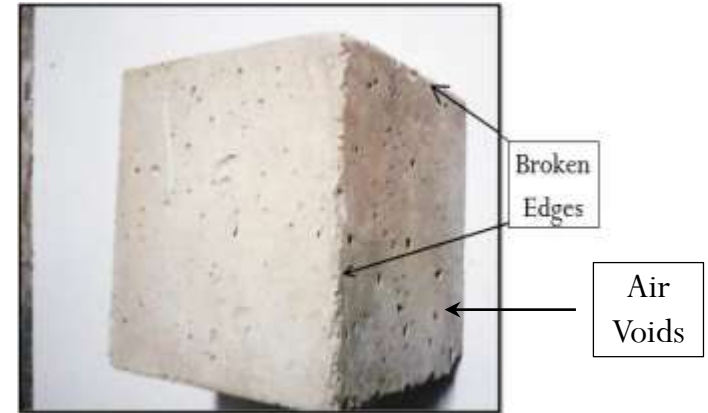


Fig. 8



## 2.5.1 Obtaining Quality Concrete Cubes :

- Fig. 9, illustrates typical concrete cube obtained at majority sites.
- Cube has broken edges and lots of Air voids.
- Such cubes give lower strength than realistic.
- 1% air voids means around 5% reduction in strength.
- In addition to above two factors, factors affecting the strength is because of unequal diagonal dimensions.
- How to Achieve Good Concrete Cubes?
- Fig.10, is the example of good cube; No broken edges, No air voids, Both diagonals are equal.



**Fig. 9 : Concrete Cube with broken edges and lots of air voids**



**Fig. 10 : Concrete Cube with straight edges and no air voids**



## 2.5.2 Obtaining Quality Concrete Cubes :

- Good edges are obtained by applying the lubricant to mould in de-assembled condition as shown in Fig. 11. This ensures non-broken edges.
- By using two mallets (Wooden or Rubber) and tamping on either sides (Fig. 12) from bottom upwards, air voids can be practically eliminated as shown in Fig. 10.
- Further by tightening the screws, opposite to each other and measuring diagonals can be made equal to 212.145mm.
- When above criteria are followed, the strength obtained will be realistic.



Fig. 11 : Applying lubricant to mould after de-assembling



Fig. 12 : Tamping the mould by two mallets from bottom to top

## 2.6.1 Curing; 24x7 for Min 10 to 14 Days :

- Curing of Concrete Essential from Strength and Durability.
- Neglected Globally, Particularly so in India.
- Curing by water, 24 x 7, is the **Best**.
- Methods to achieve are shown in Fig. 13, Fig.14, Fig. 15 & Fig. 16.

Top of the Cap Pounded with Water



Fig. 13 : Curing of Pier Cap, 24 x 7 by Water



## 2.6.2 Curing; 24x7 for Min 10 to 14 Days :

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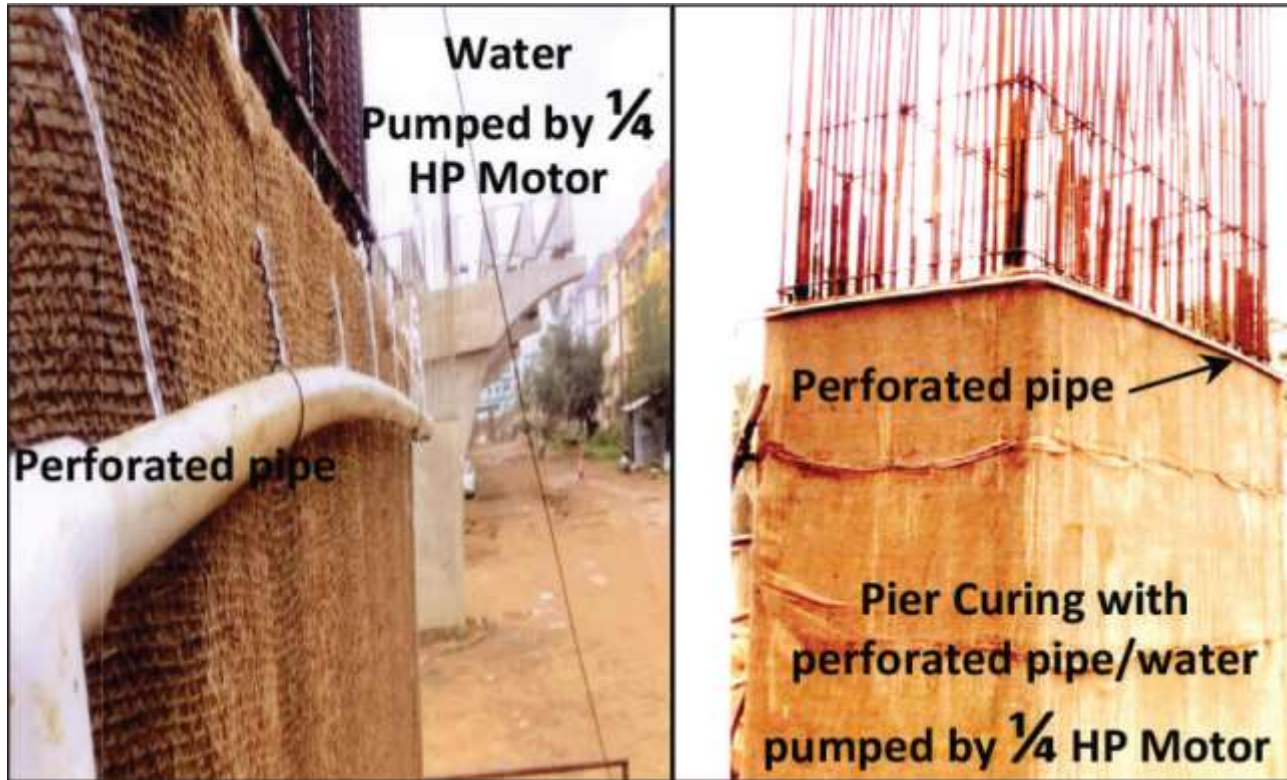


Fig. 14 : Curing of Piers/Columns, 24 x 7 by Water

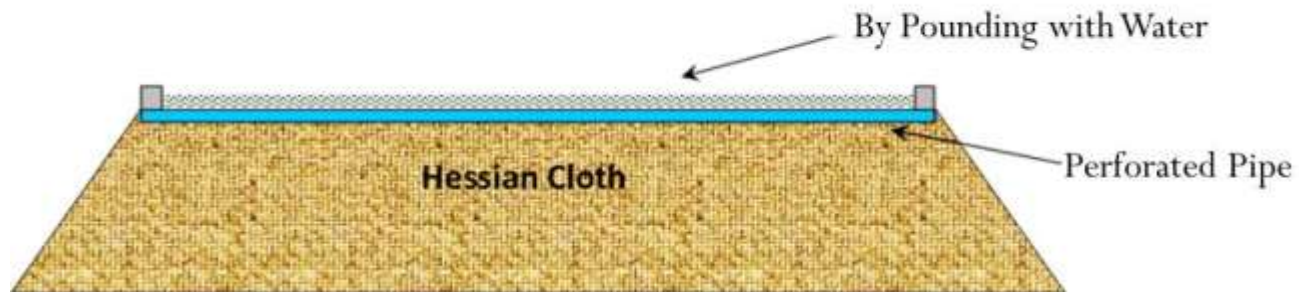


Fig. 15 : Curing of Trapezoidal Footing, 24 x 7 with water

### 2.6.3 Curing; 24x7 for Min 10 to 14 Days :



Fig.16 : Curing of precast I Girders, 24 x 7 with Water by Sprinklers.

## 2.7 Improved Productivity :

- If productivity of batching plant (BP) is  $\approx 50\%$  of the rated capacity, people are happy.
- The speaker is “Not”.
- The speaker has obtained production close to rated capacity by introducing some simple innovations. They are shown in Fig. 17, Fig. 18, Fig. 19 & Fig. 20.
- ❖ Entry and exit of Transit Mixer (TM) in the same direction at the batching plant (Refer Fig. 17). This minimized the time of travel of TM at the batching plant.

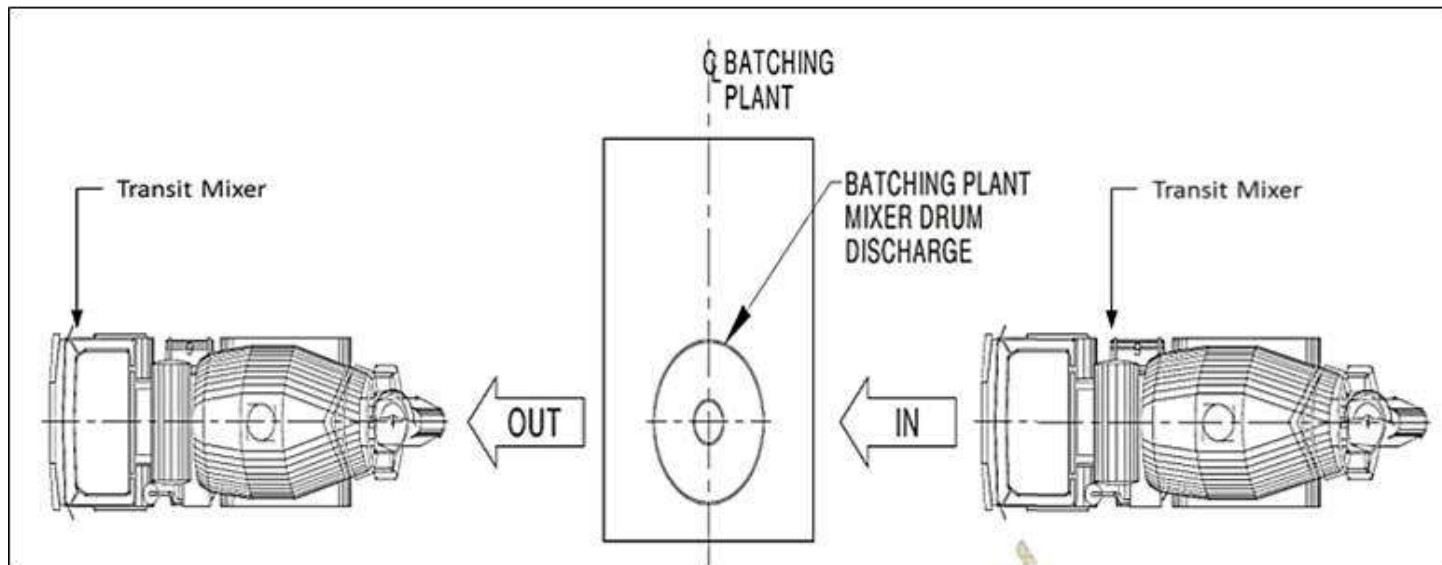


Fig. 17



## 2.7.1 Improved Productivity

(I.C. I. Journal Oct. Dec. 2016 , Vol.3 )



Fig. 18

Colour Markers

## 2.7.2 Improved Productivity :

- ❖ Increased size of TM Hopper (Fig. 19).



Fig. 19

## 2.7.3 Improved Productivity :

- ❖ Increased size of Screw Conveyor (Fig. 20).

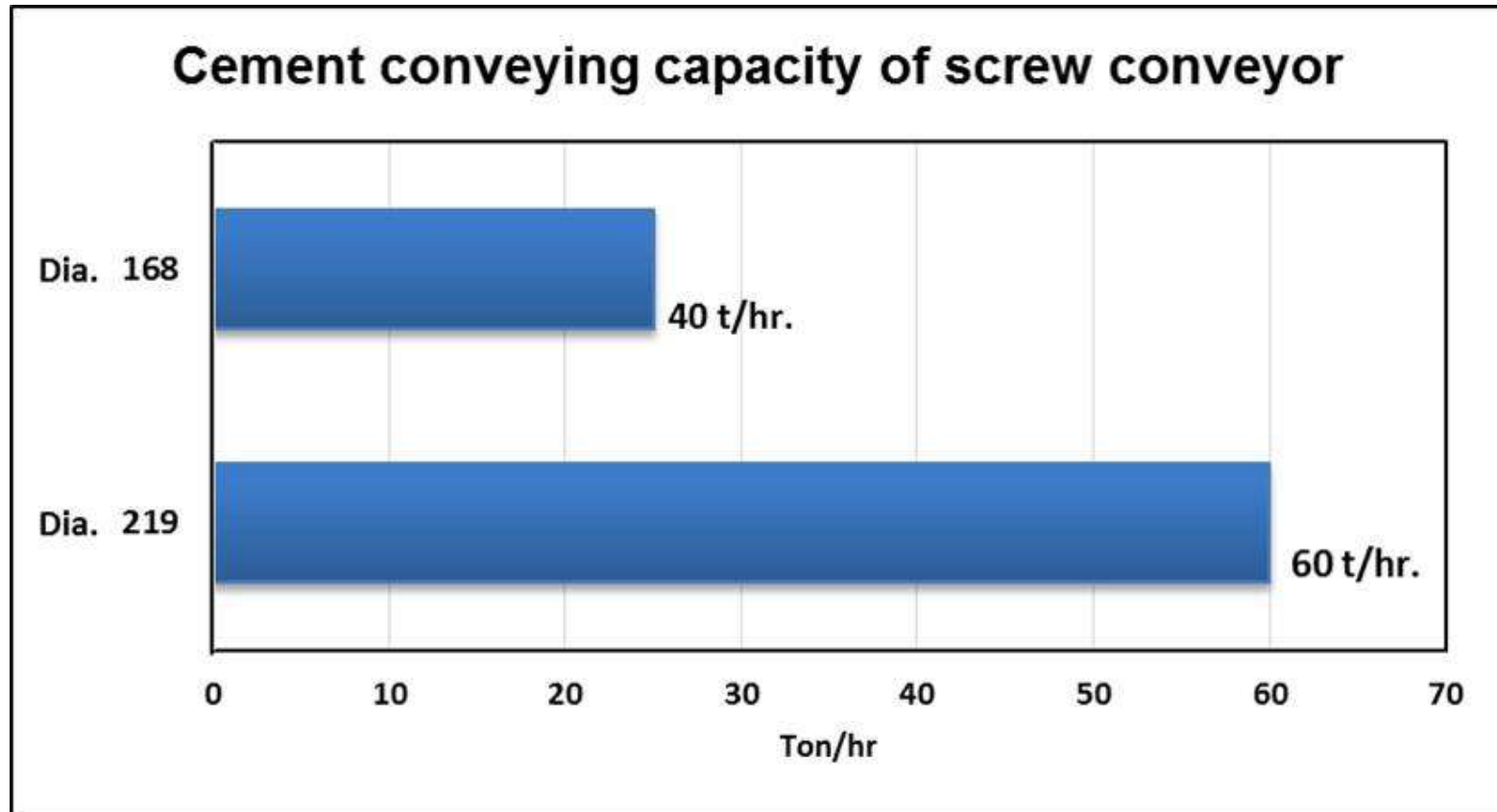


Fig. 20

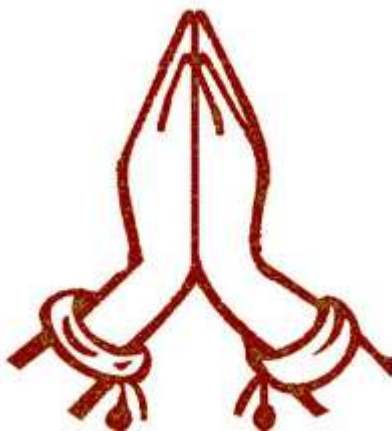
## 2.7.4 Improved Productivity :

- ❖ A 10% increase in productivity of RMC plants globally, a net saving could be of the order of INR 2500 Cr. per annum. (ICJ – The Indian Concrete Journal, August 2016, Vol. 90, No. 8)
- ❖ Thus, with 100% increase in productivity, Net saving globally is INR 12500 Cr.

## 3.0 Conclusions

- ❖ There is vast scope for improving the quality of concrete.
- ❖ Many minor details which have significant effect on quality are often neglected.
- ❖ Also there is vast scope in improving the productivity of concrete at batching plant.
- ❖ A 10% increase in productivity of RMC plants globally, a net saving could be of the order of Rs.2500 cr. per annum.
- ❖ **For Practical Innovations, Close Interaction With Practicing Professionals And Frequent Site Visits And Interaction Is Needed By R & D Team.**





**THANK YOU**

