PROPOSED CONCRETE COMPACTION METHOD USING AN ELECTRICAL INTERNAL VIBRATOR: A REVIEW OF COMPACTION STANDARD FOR CONCRETE IN LABORATORY ACCORDING TO SNI 2493:2011

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OVERVIEW

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1. BACKGROUND

- Quality of compressive strength of specimen is affected at least by :
  1. Mixing of fresh concrete (homogeneity)
  2. Compacting
  3. Curing
  4. Process of testing
  5. Quality of technician

- In the ready mix concrete industry, technicians should make concrete specimen for compressive strength test in their laboratory.
- The number of specimen is around 100 – 200 pieces everyday.
- Concrete specimen can be compacted manually using tamping rod diameter 16 mm and 60 cm of height. Each specimen is compacted as 75 times (three layer, each layer 25 times).
- A technician should conduct compaction of the specimen around 7500 – 15.000 times everyday.
- This condition (too tired) will influence perfection of specimen.

- SNI 2493: 2011 stated that compaction of specimen for compressive strength can be done using 2 method :
  1. Manually using temping rod
  2. Using Vibrator (Internal, External).
- Compaction using an internal vibrator is also regulated.
- The specimen is manufactured in the three layer and each layer is compacted using an internal vibrator 3 times.
- Unfortunately, the duration of the compaction has not been regulated yet.

2. OBJECTIVES

The aims of this study is to propose the duration of compaction method using an internal vibrator for SNI 2493:2011.

3. SPECIMENS

Mix Proportion of Concrete

Component	Weight (kg)	Concrete Property	Specification
Cement	308	w/c (%)	60
Crushed stone	1061	s/a (%)	43
Sand	800	Gmax (mm)	20
Water	185	Slump (cm)	10 ± 2

Number of specimen and type of compaction

No	Code[1]	Type of Compactor	Number of compaction	Duration of compaction (second)	Number of specimens
1	TR-25	Tamping rod	25	-	30
2	IV-3-2S	Internal vibrator	3	2	30
3	IV-3-5S	Internal vibrator	3	5	30

Compaction tool:

1. **Tamping rod : steel bar diameter 16 mm and 600 mm of length**
2. **Internal Vibrator : a vibrator diameter of 23 mm and a vibration of 200–258 Hz or 12,000–15,500 VPM (vibrations per minute). SNI 2493:2011 requires that the vibrator used should vibrate at a minimum of 1600 VPM.**

4. Experimental Procedures

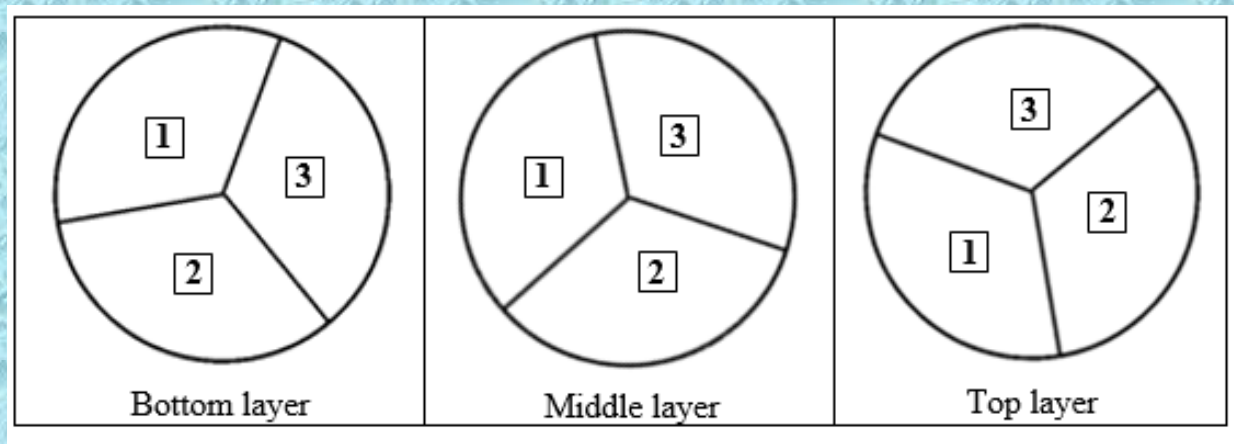
1. Mixing of raw material for concrete
   After raw material of concrete is filled in the concrete mixer, then the concreter mixer is run for 3 minutes and stop it for 3 minutes. The last running of concrete mixer for mixing is 2 minutes.
2. Slump test
   After slump cone is completely filled by fresh concrete in 3 layer and each layer is compacted using tamping rod 25 times, the slump cone is lifted perpendicularly to the base.
3. Compaction
4. Curing
   The cylinder formwork was opened 24 ± 8 hours after the concrete was casted. The specimens were then soaked in water at a temperature of 23 ± 1.7°C. After the specimens had been treated in water for 28 days
5. Compression Test
   Using Universal Testing Machine with load addition 2 - 4 kg/cm^2 per second.

Compacting fresh concrete

1. Tamping rod

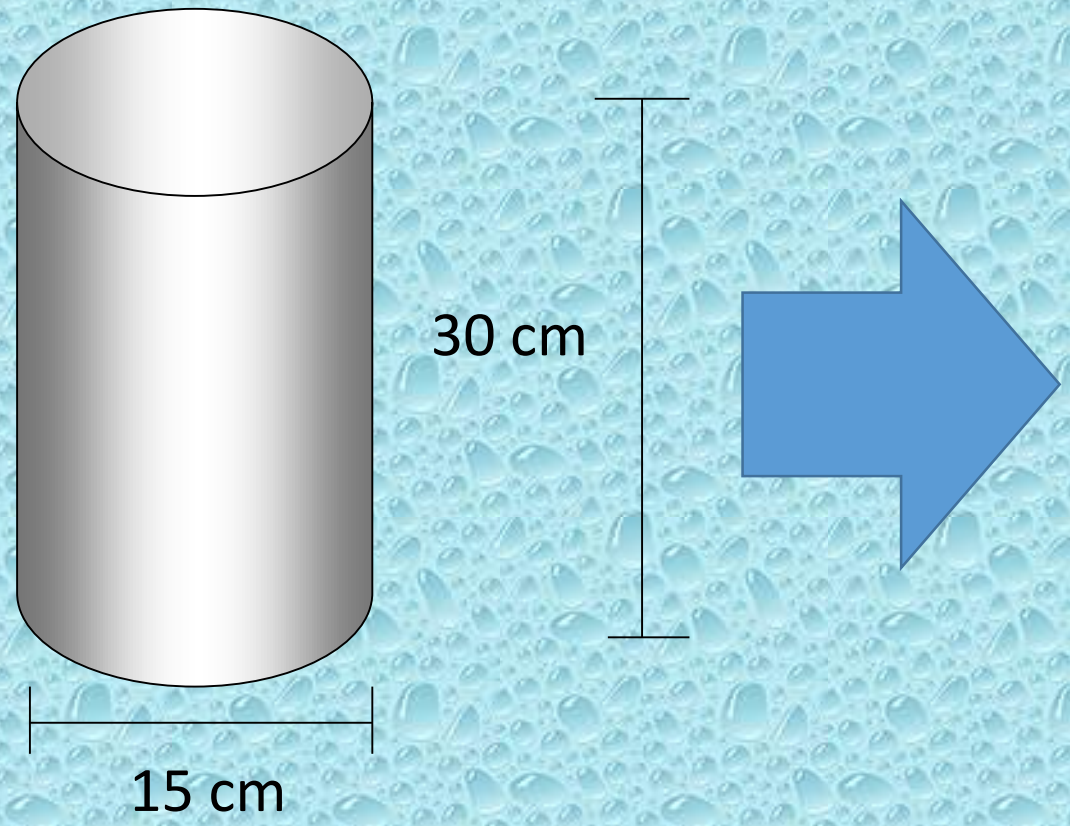
2. Internal Vibrator

Positon of the 3 compaction points in each layer



Compressive Strength

Testing is conducted after the specimens are cured by soaking in the water for 28 days.



$$\sigma = \frac{P}{A}$$

ANALYSIS OF DATA

$$\sigma'_{bk} = \sigma'_{bm} - 1.64*s$$

$$\sigma'_{bm} = \frac{\sum_1^N \sigma'_b}{N}$$

$$s = \sqrt{\frac{\sum_1^N (\sigma'_b - \sigma'_{bm})^2}{N-1}}$$

In the equation,

σ'_{bk} is the characteristic concrete strength

σ'_{bm} is the average concrete strength

σ'_b is the concrete strength of each specimen

N is the quantity of specimen

S is the standard deviation

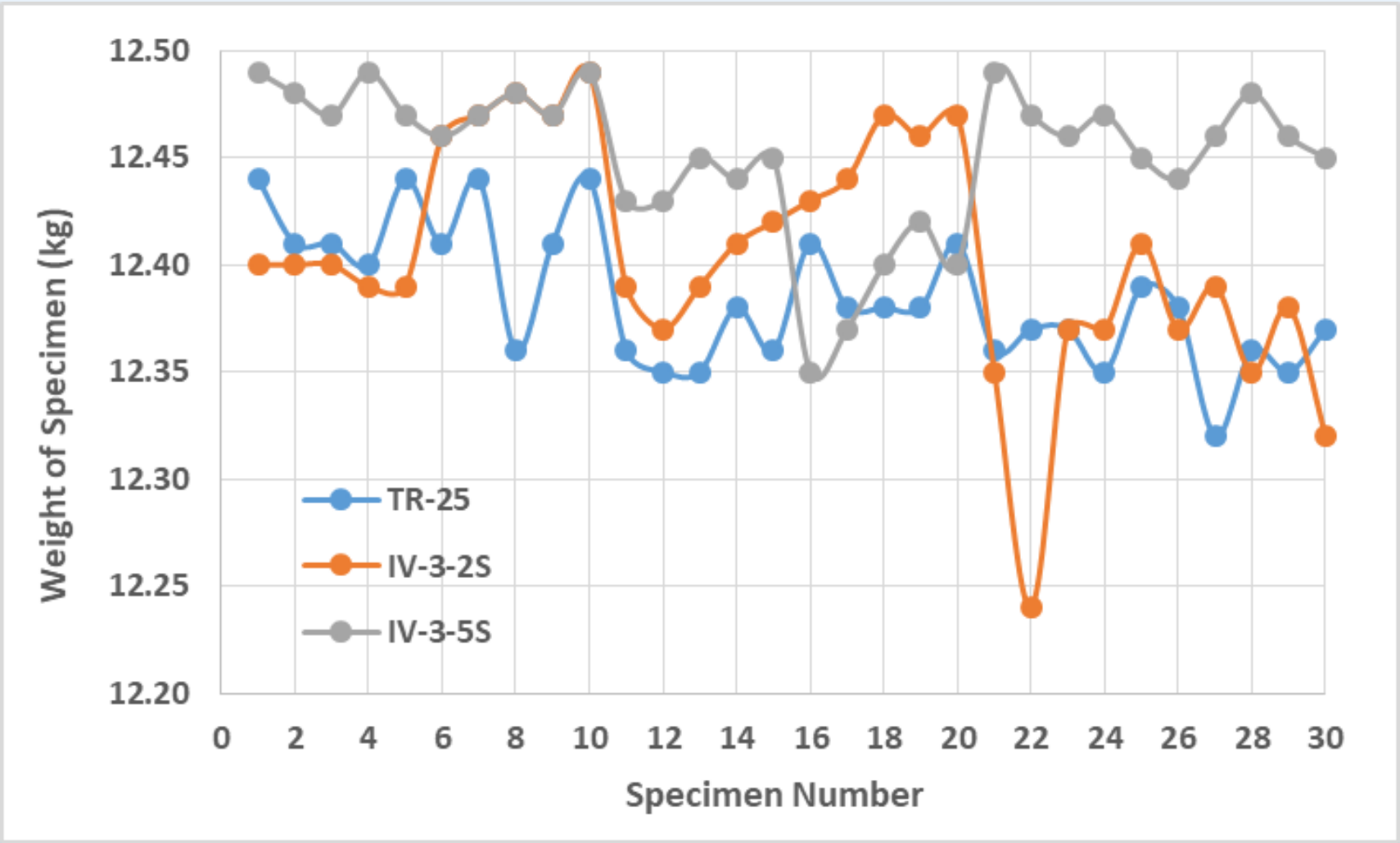
5. RESULT AND DISCUSSIONS

Temperature and Slump of Fresh Concrete

Temperature (°C)					Slump (cm)
Crushed Stone	Sand	Fresh Concrete	Ambient Air	Water	
28	25	35	25	24	10 cm

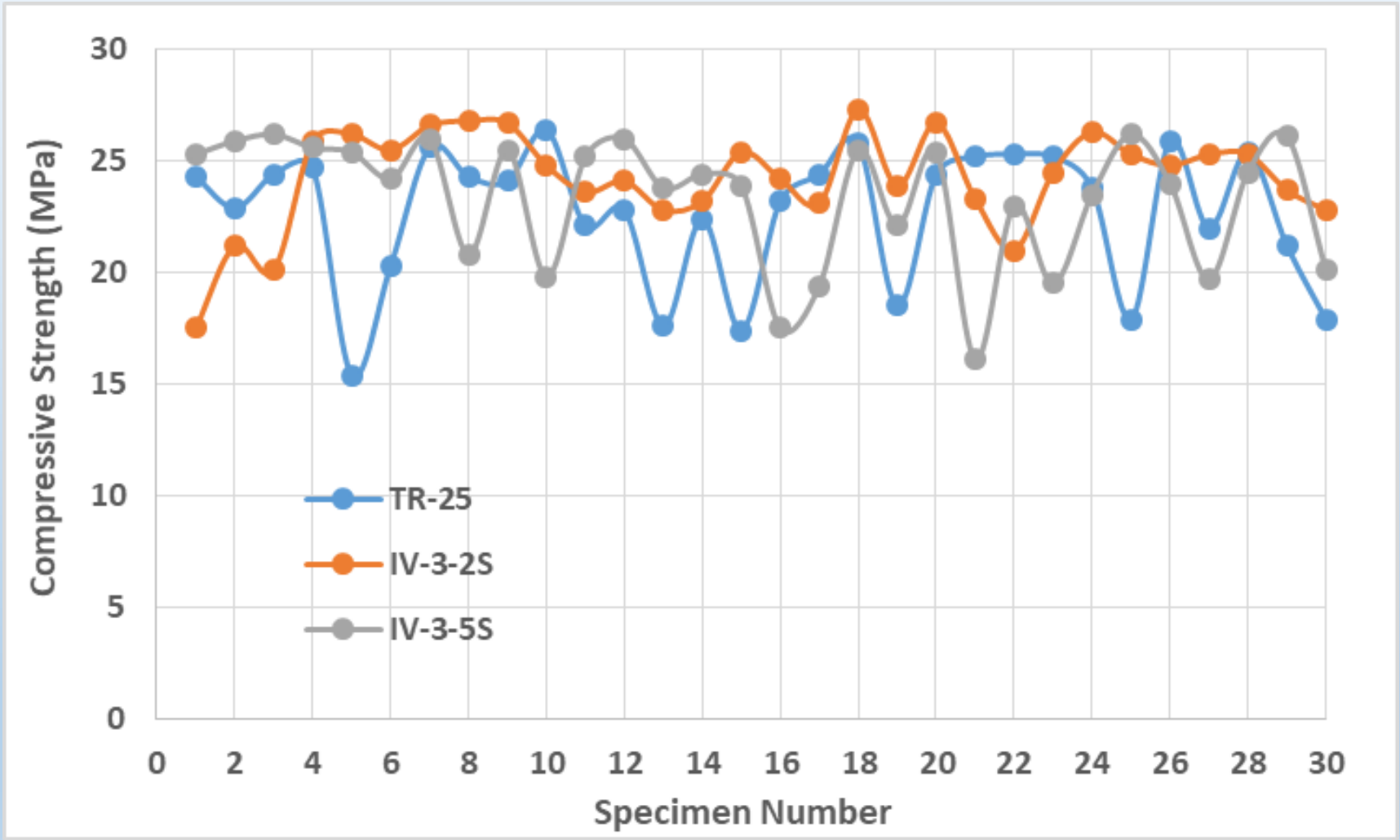
The temperatures of the crushed stone, sand, and water are in accordance with the requirements specified in SNI 2493:2011; i.e., the temperatures are within the range of 20–30°C.

Specimen Weight



The lowest average weight was found for the specimens compacted with the tamping rod, at **12.38 kg**, while the average weights of those compacted with the internal vibrator were higher; with 2 second vibration, the average weight was **12.41 kg**, and with 5 second vibration, the highest average weight was found, at **12.45 kg**.

The Characteristic Concrete Strength



The characteristic compressive strength of the test specimen compacted with the tamping rod is **19.83 MPa**, and those of the specimens compacted with the internal vibrator, for 2 and 5 seconds, are **21.82** MPa and **20.57** MPa respectively. These results indicate that compacting with the internal vibrator increases the characteristic compressive strength compared to with the tamping rod. However, when the vibration time increases from 2 to 5 seconds, the compressive strength of the concrete is reduced, despite the formation of a denser material.

This decrease in compressive strength may be caused by the segregation that occurs between coarse aggregates and the mortar at longer vibration times.

6. Conclusions

According to the above discussions, the following conclusions are summarized.

1. Concrete specimens compacted with the internal vibrator had a greater weight than the concrete specimens compacted with the tamping rod.
2. The compacting method using an internal vibrator for 2 seconds can be used to replace the compacting method using a tamping rod as stated in SNI 2493:2011. It has the highest characteristic concrete strength among 3 compacting concrete method investigated. The characteristic concrete strength is 21.82 MPa.
3. Compaction with the internal vibrator for 5 seconds caused segregation and thus decreased the compressive strength of the concrete. The compressive strength is 20.57 MPa.
4. Concrete specimen compacted with the tamping rod has the lowest characteristic strength. The compressive strength of the concrete is 19.83 MPa.

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THANK YOU