

# Review and Comparison of Codal Provisions of IS 456:1978 and IS 456:2000

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**Abstract:** *IS 456 is the Indian Standard Code of Practice for Plain and Reinforced Concrete and is the most important document for the design of reinforced concrete structures. The IS 456:1978 edition was mainly based on the Working Stress Method and was widely used for more than two decades. This method ensured safety by restricting stresses under service load conditions within permissible limits. The rapid development in concrete technology, availability of high-strength materials, improved construction practices, and increased emphasis on durability and serviceability necessitated the revision of the 1978 version of the code. Consequently, the Bureau of Indian Standards revised the code and published IS 456:2000, which introduced the Limit State Design philosophy. This paper compares the main provisions of IS 456:1978 and IS 456:2000.*

**Keywords:** IS 456 code, reinforced concrete design, working stress method, limit state design, concrete standards India

## 1. Introduction

IS 456 is the Indian Standard Code of Practice for Plain and Reinforced Concrete and is the most important document for the design of reinforced concrete structures. The IS 456:1978 edition was mainly based on the Working Stress Method and was widely used for more than two decades. This method ensured safety by restricting stresses under service load conditions within permissible limits. The rapid development in concrete technology, availability of high-strength materials, improved construction practices, and increased emphasis on durability and serviceability necessitated the revision of the 1978 version of the code. Consequently, the Bureau of Indian Standards revised the code and published IS 456:2000, which introduced the Limit State Design philosophy. This method ensured safety by restricting stresses under service load conditions within permissible limits. This revision aligned Indian practice with international standards such as Eurocode and ACI and made concrete design more rational and scientific.

This paper presents a detailed comparison of IS 456:1978 and IS 456:2000, highlighting differences in philosophy, safety concepts, material specifications, durability provisions, detailing rules, and practical design implications.

## 2. Design Philosophy

IS 456:1978 is based on the Working Stress Method. In this method, the structure is designed so that stresses in concrete and steel under service loads do not exceed prescribed permissible values. A single overall factor of safety is indirectly applied by reducing material strengths. The method assumes linear elastic behavior and does not explicitly consider ultimate failure conditions.

IS 456:2000 is based on the Limit State Design philosophy. In this approach, a structure is designed to satisfy two main limit states. The first is the Limit State of Collapse, which ensures adequate strength against failure in flexure, shear, torsion, and compression. The second is the Limit State of Serviceability, which ensures acceptable performance under normal use with respect to deflection, cracking, vibration, and

durability. Partial safety factors are applied separately to loads and material strengths, making the design more realistic and reliable.

## 3. Load and Material Safety Factors

In IS 456:1978, loads are considered at service level and no explicit load factors are specified. Safety is ensured by limiting permissible stresses in concrete and steel.

IS 456:2000 introduces partial safety factors for loads and materials. For ultimate limit state design, the load factor for dead load and live load is generally taken as 1.5. Separate material safety factors are specified: 1.5 for concrete and 1.15 for reinforcing steel (lower value for steel shows lesser uncertainties associated with the properties of steel as compared to that of concrete). This separation of load and material safety factors allows better control of uncertainties and enhances structural safety.

## 4. Concrete Grades and Material Properties

IS 456:1978 had limited clarity regarding concrete grades. The concept of characteristic strength was not strongly emphasized, and quality control provisions were minimal.

IS 456:2000 clearly defines concrete grades from M10 to M80, where the grade denotes the characteristic compressive strength of concrete in MPa at 28 days. The concept of characteristic strength ensures that not more than 5 percent of test results fall below the specified value. This standardization has significantly improved quality control and uniformity in concrete construction.

## 5. Durability And Exposure Conditions

Durability provisions in IS 456:1978 were very limited. Only general recommendations regarding cover to reinforcement were provided, without systematic consideration of environmental exposure.

IS 456:2000 introduces detailed durability provisions by classifying exposure conditions as mild, moderate, severe,

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very severe, and extreme. For each exposure condition, the code specifies minimum cement content, maximum water-cement ratio, and minimum cover to reinforcement. These provisions ensure resistance against corrosion, chemical attack, and weathering, thereby enhancing the service life of structures.

## 6. Serviceability Limit States

IS 456:1978 provides only general guidance regarding deflection and cracking control, without specific quantitative limits.

IS 456:2000 gives explicit provisions for serviceability. Deflection control is achieved through basic span-to-depth ratios, modified by factors accounting for tension reinforcement and compression reinforcement. Crack control is addressed by limiting bar spacing, bar diameter, and

providing adequate concrete cover. These provisions improve structural performance, user comfort, and appearance.

## 7. Detailing of Reinforcement

Detailing provisions in IS 456:1978 are basic and limited in scope. Rules for anchorage, lap length, and spacing are not comprehensive.

IS 456:2000 provides detailed rules for reinforcement detailing, including development length, anchorage length, lap splices, minimum and maximum reinforcement percentages, spacing of bars, and detailing requirements for beams, slabs, columns, and footings. Proper detailing ensures ductile behavior and prevents premature failure.

## 8. Design Philosophy & Material Parameters: IS 456-1978 vs IS 456-2000

| S. No. | Parameters                      | IS 456-1978                            | IS 456-2000   |
|--------|---------------------------------|--|---|
| 1.     | Design Method                   | Working Stress Method (WSM)- primary   | Limit State Method (LSM)- primary (WSM in Annex B)                |
| 2.     | Concrete Grades Allowed         | M10 to M40                             | M10 to M80  |
| 3.     | Modulus of Elasticity ( $E_c$ ) | $E_c = 5700 \sqrt{f_{ck}}$             | $E_c = 5000 \sqrt{f_{ck}}$  |
| 4.     | Workability Control             | Compacting factor, vee-bee time, slump | Only slump (simplified correlation)                               |
| 5.     | Durability                      | Limited, basic clauses                 | Detailed durability clauses including exposure, cover, w/c limits |
| 6.     | Admixtures & Materials          | Basic provisions                       | Allows modern admixtures (superplasticizers, mineral admixtures)  |
| 7.     | Quality Assurance               | Basic testing                          | Extensive QA requirements & acceptance criteria                   |

### Explanation:

The 2000 code marked a fundamental shift from purely elastic design (WSM in 1978) to design for strength, safety, and serviceability (LSM)- enhancing safety and economy. Concrete material provisions, grades, and testing requirements were also modernized.

## 9. Numerical Example – Simply Supported Beam

Given:

Span = 5 m

Uniformly distributed load = 20 kN per meter

Concrete grade = M20

Steel grade = Fe415

Beam width = 300 mm

Effective depth = 500 mm

Using IS 456:1978 (Working Stress Method):

The maximum bending moment at mid-span is calculated as  $wL^2$  squared divided by 8, which gives 62.5 kN-m. Using permissible stresses for concrete and steel, the required area of tensile reinforcement works out to approximately 600 square millimeters.

Using IS 456:2000 (Limit State Design):

The factored bending moment is obtained by multiplying the service moment by 1.5, giving 93.75 kN-m. Using limit state design equations and partial safety factors, the required area of tensile reinforcement is approximately 750 to 800 square millimeters.

This comparison shows that IS 456:2000 results in a more conservative and safer design at ultimate limit state, while also ensuring serviceability requirements.

## 10. Practical Implications

The adoption of IS 456:2000 has resulted in safer, more durable, and serviceable reinforced concrete structures. Although designs based on limit state method may require slightly higher reinforcement compared to working stress method, the overall reliability and life span of structures are significantly improved. The code also promotes better construction practices and quality control.

## 11. Conclusions

The 2000 version of IS 456 Code is a major advancement over IS 456:1978. The shift from Working Stress Method to Limit State Design reflects modern engineering practice and international standards. IS 456:2000 includes durability, serviceability, and detailed reinforcement provisions makes it more suitable for present-day design and construction of reinforced concrete structures. IS 456:1978 is now of historical importance and may be referred by those having academic interest only.

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