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Cement Types in American & European Standards

By Wasam Al Rayes - Technical Engineer

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Features

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Cement is considered to be a product of particular importance for the stability and performance of the structure, different Standards and specifications across the countries specify different cements types based on different criteria. This article will compare the different types of cement in ASTM and EN.

Types of Cement According to EN 197-1

The European Standard categorizes cements into five main groups based on their additives, and each group is divided into sub-groups, to a total of 27 distinct common cements, 7 sulfate resisting common cements, 3 distinct low early strength blast furnace cement and 2 sulfate resisting low early strength blast furnace cements.

The five main groups are:

• CEM I Portland cement

Consist of Portland cement and up to 5% of minor additional constituents (such as: fly ash).

• CEM II Portland composite cement

Consist of Portland cement and up to 35% of certain other single constituents.

• CEM III Blastfurnace cement

Consist of Portland cement and proportions of blast-furnace slag, up to 95%.

• CEM IV Pozzolanic cement

Consist of Portland cement and higher proportions of pozzolana than in a CEM II cement.

• CEM V Composite cement

Consist of Portland cement and combinations of more than one additive.

Types of Cement According to ASTM C150, C595, and C1157

On the other hand, ASTM categorizes common cements, Portland cement sand blended hydraulic cements, based on their properties and uses, into 14 types:

Type I

Ordinary Portland Cement, for use when the special properties specified for any other type are not required

Type IA

Air-entraining cement for the same uses as Type I, where air-entrainment is desired

Type II

General use and moderate sulphate resistant cement.

Type IIA

Air-entraining cement for the same uses as Type II, where air-entrainment is desired.

Type II(MH)

For general use, more especially when moderate heat of hydration and moderate sulfate resistance are desired.

Type II(MH)A

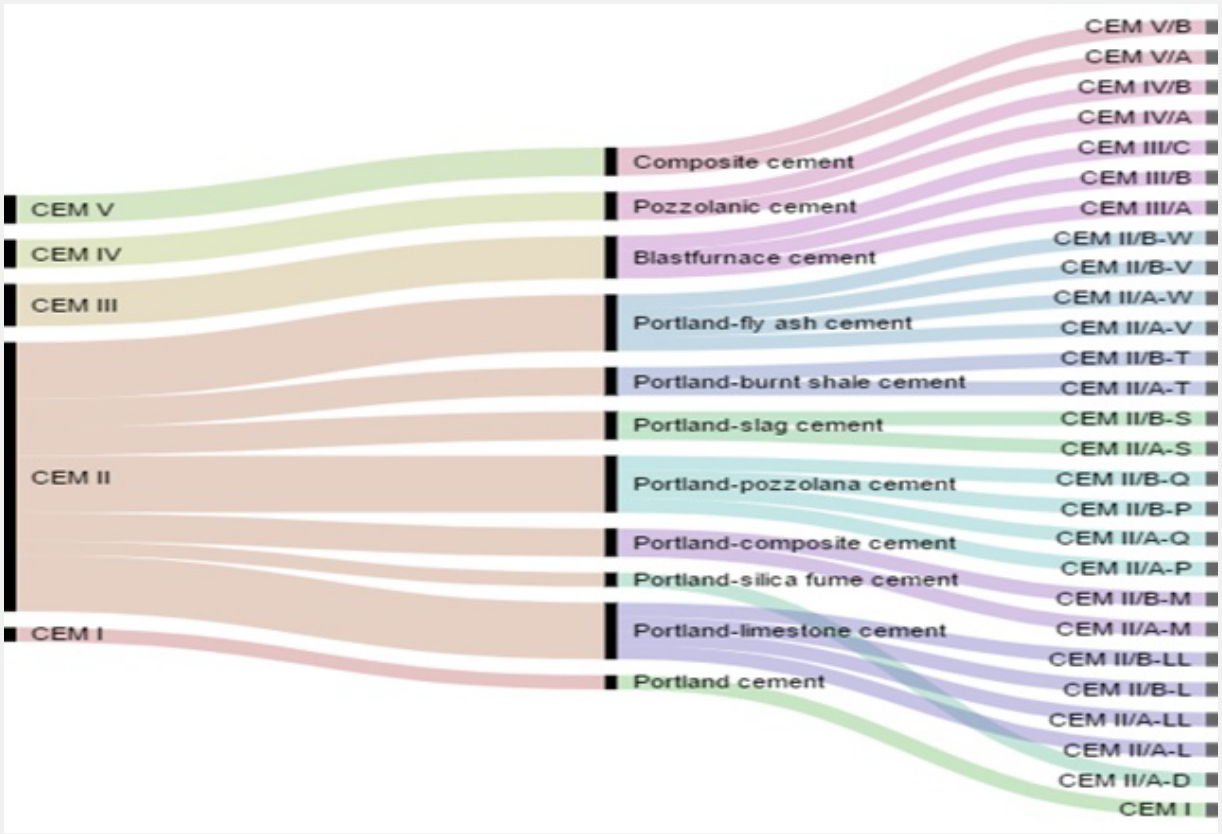
Air-entraining cement for the same uses as Type II(MH), where air-entrainment is desired.

- **Type III:** High early strength cement
- **Type IIIA:** High early strength cement and air entrained agents.
- **Type IV:** Low heat cement.
- **Type V:** High sulphate resistant cement
- **Type IS:** Portland blast-furnace slag cement.
- **Type IP:** Portland-pozzolan cement.
- **Type IL:** Portland-limestone cement.
- **Type IT:** Ternary blended cement.

ASTM recently published C1157, which can be said it emphasizes the ability of the cement to perform rather than the usual prescriptive specification C150. C1157 defines 6 types of cement:

- **Type GU:** Hydraulic cement for general construction. Used when one or more of the special types are not required.
- **Type HE:** High Early-Strength.
- **Type MS:** Moderate Sulfate Resistance.
- **Type HS:** High Sulfate Resistance.
- **Type MH:** Moderate Heat of Hydration.
- **Type LH:** Low Heat of Hydration

Any of these types can be purchased with low resistivity with Alkali-Reactive Aggregates donated with the latter R.



Special Properties

Special properties such as sulphate resisting, Low heat of hydration, and high early strength can be obtained by adjusting the constituents and additives of cement. Table 1 shows the types of cement in ASTM and the corresponding Types in EU with the same properties.

Properties	ASTM C150, C595	EN 197-1
Sulphate Resisting	Type II, Type V, Type IS(MS), Type IS(HS), Type IP(MS), Type IP(HS), Type IL(MS), Type IL(HS)	CEM I-SR0, CEM I-SR3, CEM I-SR5, CEM III/B-SR, CEM III/C-SR, CEM IV/A-SR, CEM IV/B-SR
High Early Strength	Type III	Three classes of early strength are defined for each class of standard strength: • Ordinary early strength, indicated by N. • High early strength, indicated by R. • Low early strength, indicated by L (only applicable for CEM III cements). **For example:** CEM II/A-L, 32.5 N and CEM I 42,5 R
Low Hydration Heat	Type IV	All types of cement identified by the notation "LH", for example: CEM III/B-LH

Table 1. Types of cement in ASTM and the corresponding Types in EU with the same properties

Although some types have the same performance or property in ASTM and EN, they have different chemical and physical requirements, for instance: Type IV in ASTM and Type CEM III/B-LH in EN are both low hydration heat cement but in EN 197-1 the heat of hydration for low heat common cement is limited to 270 J/g while in ASTM is limited to 225 J/kg. Table 2 gives an example of sulphate resisting Portland cement in ASTM and EN and their requirement and specifications.

In the binary blends we also find that, Type IS in ASTM and Type CEM III in EN, both are consisting of Portland-slag cement, and both standards allow slag constituent up to 95%.

But in the other hand, Type IP in ASTM and Type CEM IV are both Portland-pozzolan cement, but in Type IP in ASTM, pozzolan can replace up to 40% of the mass, while Type CEM IV, up to 55% of mass by pozzolan.

Cement Type	ASTM		EN		
	II	V	CEM I-SR 0	CEM I-SR 3	CEM I-SR 5
C_3A Content	8 %	5 %	0	≤ 3%	≤ 3.5%.
SO_3	3 %	2.3 %	≤ (3 – 3.5) % depending on strength class	≤ (3 – 3.5) % depending on strength class	≤ (3 – 3.5) % depending on strength class
MgO	6 %	6 %	5 %	5 %	5 %
Loss of Ignition	3 % when limestone is not an ingredient 3.5 % when limestone is an ingredient	2.5 % when limestone is not an ingredient 3.5 % when limestone is an ingredient	≤ 5%	≤ 5%	≤ 5%
Insoluble Residue	3 %	3 %	≤ 5 %	≤ 5 %	≤ 5 %

Table2. Main types of sulphate resisting Portland cement in ASTM and EN and their requirements

Plastic Fibers: Benefits & Drawbacks

By Tareq Yanbawi - Technical Engineer

Introduction

A fiber is a substance where the length is longer than its width and there are many kinds of fibers some of them natural extracted from plant or mineral sources, and the other are man-made which are the most type used in these days. Fibers were used as reinforcement in the concrete since ancient time in the form of straw and horse hair. Nowadays, various types of fibers have been used to help improve the quality of the concrete such as steel, glass and synthetic fibers. There are two main categories for fibers used in the concrete:

A. Plastic Fibers used mainly for cracking control.
B. Metallic Fibers used for strength, absorbtion and impact resistance.

Synthetic Macro-Fiber

Polypropylene Fiber

In this article, we only will discuss the Plastic fibers which is the most common material in use. Plastic fibers appear in the market in either synthetic (made from the petrochemical and textile industries) or polypropylene (a fully chemical substance). Also, either Macro or Micro depend on the size of the fibers.

Type of Shrinkage Cracks

Plastic Shrinkage

Drying Shrinkage

There are two main type of shrinkage that could occur to the concrete:

A. Plastic shrinkage appear in the surface of fresh concrete after placing it and while it is still in the plastic phase. It occurs normally in horizontal surfaces and usually in parallel lines. It happen due high rate of evaporation of water before the concrete has set and due to inappropriate curing.

B. Drying Shrinkage appears in the surface of hardened concrete due to loss of water. It causes an increase in tensile stress and volume changes which will lead to crack or deflection. It can occur in all parts of the structure such as slabs, beams, columns and foundations.

Actual Studies

A research paper in (Al-Tulaian et al, 2014) has used a recycled plastic fiber with two lengths of 20 mm and 50 mm and added in the three different percentage 0.5, 1.0 and 1.5 to compare to the base mix (Figure 1 & 2) . Results show that cracks from plastic shrinkage decrease with a higher fiber content until it disappears with 1.5% of 50 mm fiber. Also results show that there is a slight increase in the compressive strength due to adding fibers to the mix design.

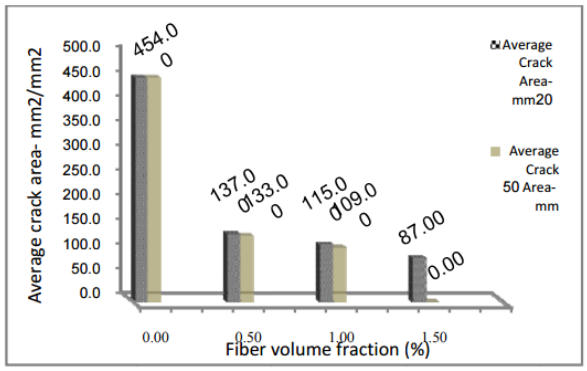


Figure (1) Crack Area with different percentage of plastic fibers with 20 mm and 50 mm

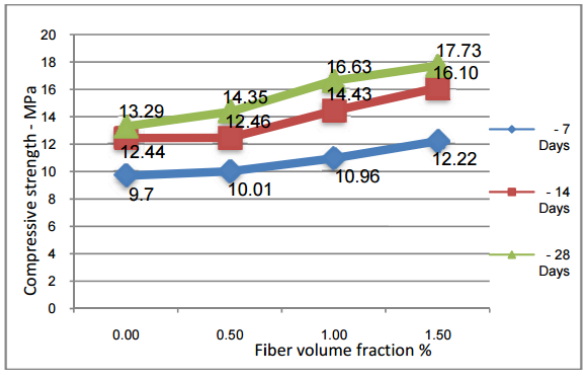


Figure (2) Compressive strength with different percentages of 50 mm plastic fiber

Another study published (Nibudey, 2013) showed that compressive strength increase at first up to 1.5% when its decrease after the excess amount of fibers (Table 1).

Advantages of using Plastic Fibers

1) Control and minimize the crack due the plastic shrinkage (as shown in the previous experiment) and the drying shrinkage as well.

2) Slight increase to the compressive strength.

3) Decrease the concrete permeability and in result improve the durability.

4) No corrosion will affect the fibers if you compare it to the metallic fibers which will lead to increase the service life.

5) Increase cohesion on the mix which will lead to reducing the settlement and a better finishing.

Disadvantages of using Plastic Fibers

1) Adding fibers may not increase the compressive strength as wanted due to the balling affect which happen when fibers form clumps inside the mix but it can be avoid it by proper mixing.

2) Cannot control orientation of the fibers 100% which may lead to some fibers free zones.

3) Existence of a huge number of fibers type for example for BASF company there are more than 18 different type of fiber which need to careful study to each type to know what is the best substance for a specific design mix

Conclusion

Fiber concrete is a large field becoming more important with time. Adding small part of different types of fibers will enhance the quality of concrete. Research is still underway around the world about using fibers and improve it. Hope this article add to the knowledge in this field which may consider to be the future of concrete industry.

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