Cast Iron vs. Ductile Iron Housing Material

The Relative Merits of Cast Iron Housings

Various grades of cast iron have been widely applied and used in a multitude of industrial machinery for many years. The use of cast iron as a housing material in gearboxes of all sizes and configurations has been especially prevalent. That trend continues today, with ***the majority of the medium to large reducer housings being made of cast iron***.

The reasons for the pre-eminence of cast iron, as a reducer housing material, are many, including:

1) Structural rigidity,
2) High strength, especially in compression,
3) Good strength to weight ratio,
4) High machinability,
5) Corrosion resistance,
6) Inherently sound absorbing,
7) Excellent castability, making it easy to cast into complex shapes with simple and inexpensive patterns and
8) Relative abundance or raw materials.

The different grades of iron are named by their chemistry and their strength. For example, in the USA, Grey Cast Iron, Grade 30 is a specific chemical composition, processed in a manner to obtain yield strength of 30,000 psi. Cast irons in grades 20 and 30 are the materials most frequently specified in the construction of reducer housings.

Where greater strength for more demanding applications is required, it is possible to adjust the chemistry and the iron making process to obtain a much stronger material: Ductile Iron. ***Ductile iron is typically twice as strong as many grey cast irons, and nearly as strong as steel.*** While ductile iron shares many of the advantages of cast iron, the ductile iron is more difficult to cast, and has a different shrink rate than cast iron. This difference means different patterns are required.

In the case of Sumitomo, because we are a subsidiary of a Japanese company, we use a classification system called the Japanese Industrial System (JIS) to classify many things including metals. In the Cyclo products, and their derivatives, cast iron grade uses is typically FC200 *(Figure 1)*, with the ductile iron being FCD450 *(Figure 2)*.

Figure 1. Cast Iron Example

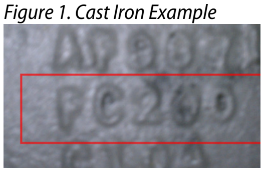
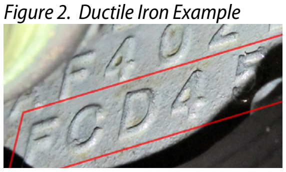


Figure 2. Ductile Iron Example



Casting Materials

Casting material properties have been standardized by global industrial societies, such as JIS (Japan Industrial Standards) and ASTM (American Society for Testing and Materials). Tensile strength is the defining characteristic of (Grey) cast iron and the grade is cited in the name of the material (refer to the material properties below to understand the relationship). The two grades that Sumitomo uses are identified below.

> Grey Cast Iron

JIS Specification:	FC200 (BBB5 Standard*) 200 N/mm² Tensile Strength	**Sumitomo Specification:**	*ASTM A48 Class No. 35 (equivalent)* *35,000psi Tensile Strength*
	FC250 (equivalent) *250 N/mm² Tensile Strength*		*ASTM A48 Class No. 40 (equivalent)* *40,000psi Tensile Strength*

** BBB5 Size-Z housing material is tempered die-cast aluminum – JIS AC4C-T6(Standard) or ASTM B26-536-T6 (equivalent)*

Each standard has slight variations, and due to conversions, we can say: FC200 < A48 No.35 < FC250 < A48 No.40. Elongation of the material or the ability to 'flex' is the defining characteristic of ductile (nodular) iron. Ductile iron grades can be classified from the variations in the tensile strength, yield strength, and the elongation. Elongation is the % of stretch of a 2" or 50mm sample and it is important enough to be identified in the different material grades (shown as the suffix in each grade). The ASTM (Sumitomo) specification readily identifies the tensile, yield and % elongation respectively, in the grade.

> Ductile Iron

JIS Specification:	FCD450-10 (BBB4 Standard) 10% elongation	**Sumitomo Specification**	*ASTM A536-65-45-12 (equivalent)* *65ksi Tensile; 45ksi Yield; 12% elongation*

Cast Iron vs. Ductile Iron Housing Material *(Continued)*

The housing material can be identified directly inside the housing through raised cast lettering. FCD will indicate Ductile Iron and FC will indicate Cast Iron *(See Figures 1 and 2)*.

When the grain is viewed under a microscope, ductile iron has a spheroidal shape where the cast iron reveals a flaky composition. Refer to *Figures 3 and 4*. These rounded shapes allow for more flexibility. The grain structure difference helps to define the strengths and weakness of each material.

Figure 3. Ductile (nodular) Iron Grain Structure

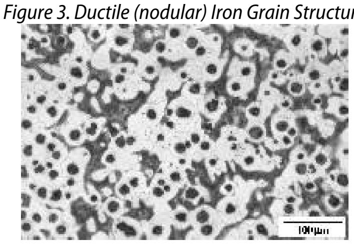
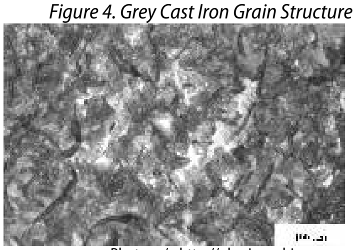


Figure 4. Grey Cast Iron Grain Structure



Photos c/o http://physicsarchives.com

Material	Properties	Strengths	Weakness
Cast Iron	Tensile FC200 ≥ 200 N/mm^2 [29,008psi] FC250 ≥ 250 N/mm^2 [36,259psi] A48 No.35 ≥ 35,000psi [241 N/mm^2] A48 No.40 ≥ 40,000psi [275 N/mm^2]	▪ High Strength/Weight ▪ Low Production Cost ▪ High Machinability ▪ Vibration Dampening ▪ Excellent up to moderate shock loading ▪ Superior compressive strength compared to steel	▪ Lower tensile strength compared to steel ▪ More brittle compared to ductile or steel when used for shock loaded applications ▪ Temperatures below 30˚F/ 0˚C are susceptible to thermal/impact shock and brittle failure.
Ductile Iron	*Tensile* FCD450 ≥ 450 N/mm^2 [65,260 psi] A536 65-45-12 ≥ 65,000psi [448 N/mm^2] *Yield* FCD450 ≥ 280 N/mm^2 [40,610 psi] A536 65-45-12 ≥ 45,000psi [310 N/mm^2] *Elongation* FCD450-10 > 10% A536 65-45-12 > 12%	▪ High Fracture Toughness (Ability to resist fracturing) when compared to cast iron) ▪ High Fatigue Strength compared to cast iron ▪ High Machinability ▪ Vibration Dampening ▪ Excellent for shock and impact loading ▪ Similar casting/pouring properties to cast iron ▪ Excellent cost / ratings improvement	▪ Slightly higher coefficient of expansion than cast iron. ▪ Slightly lower machinability compared to cast iron. ▪ Only slightly higher brittleness from cast iron below -25°C (-13°F)

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