

ArcelorMittal Rodange



ArcelorMittal

Krybar[®]
Safety



Krybar® is a special designed concrete reinforcing steel for cryogenic applications. In comparison with today's standard reinforcing steel, Krybar® has a high ductility at very low temperature, down to -170°C (-274°F). Due to its special steel composition, even notched bars show plastic deformation before breaking.

ArcelorMittal Rodange is producing Krybar® since 1980. Krybar® has been developed on request of the gas industry in order to provide tailor-made concrete reinforcing steel for safest cryogenic applications.

Today **ArcelorMittal Rodange** offers a wide range of Krybar Grades determined by their different design temperatures:

- **KRYBAR -50** for LPG tank with temperature down to -50°C
- **KRYBAR -105** for ETHYL tank with temperature down to -105°C
- **KRYBAR -165 & KRYBAR 620** for LNG tank with temperature down to -170°C

For qualifying concrete reinforcing steel at cryogenic temperature, following criteria are used:

- $Agt_{\text{unnotched bar}} > 3\%$
uniform elongation on unnotched bars : minimum 3
- $Agt_{\text{notched bar}} > 1\%$
uniform elongation on notched bars : minimum 1
the elongation of the notched bar demonstrates the ductility reserve Krybar® provides after bending or local damage

- Notch Sensitivity Ratio ≥ 1

$$NSR \geq \frac{\text{Tensile strength of the notched bars}}{\text{Lower yield strength of unnotched bars}}$$

- $Re_{\text{unnotched bars}} = \min 1.15 \times \text{Design } Re$

By using Krybar® you have the insurance that all the above requested criteria are satisfied which will be specified in a 3.1 certificate issued for each heat delivered.

Krybar® fulfills the EN14620 & BS7777 at low temperature and the BS4449 2005 Grade B500B at ambient temperature with:

- $Re_{\text{min}} = 500 \text{ MPa}$
- $Rm_{\text{min}} = 550 \text{ MPa}$
- $Rm/Re_{\text{min}} = 1,08$
- $Agt_{\text{min}} = 5\%$

Available diameters: 12, 16, 20, 25, 28 and 32 mm.

Krybar® has been field approved in the construction of more than 200 tanks worldwide in the past 30 years and it has so become the international product reference.

Reference list:

Europe: Fos-Cavaou (France), South Hook LNG, Milford Haven, Dragon LNG, Isle of Grain, Mossmorran (United Kingdom), Barcelona, Mugardos, Sagunto, Huelva, Cartagena, Bilbao, Gijón (Spain), Snøhvit, Risavika (Norway), Nynäshamn (Sweden), La Spezia (Italy), Revithoussa (Greece), Sines (Portugal)

Asia: RasGas LNG, QatarGas I+II (Qatar), Pars LNG, Bushehr, Iran LNG (Iran), Jiansu, Dalian, Guangdong, Fujian, Shanghai, Ningbo, Ningxia (China), Incheon (South Korea), Sakhalin (Russia), Kochi, Hazira, Dahej, Dabhol, Gujarat (India), Abu Dhabi, Das Island ADGAS LNG, Oman (United Arab Emirates), Bintulu (Malaysia), Lumut (Brunei), PTT LNG (Thailand), Darwin, Pluto LNG (Australia), Yemen LNG (Yemen), Singapore LNG (Singapore)

America: Cameron, Yankee Gas, Freeport, Cheniere Sabine Pass, Gulf LNG (United States), Atlantic LNG (Trinidad and Tobago), Altamira, Costa Azul, Manzanillo (Mexico), Guayanilla Bay (Puerto-Rico), Peru LNG (Peru), Quintero LNG (Chile), Canaport LNG (Canada)

Africa: Skikda LNG (Algeria), ELNG Idu, Damietta (Egypt), Bonny Island (Nigeria), Angola LNG (Angola)

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