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2. LNG Storage Tanks in Bintulu (Malaysia)

Owner: *Malaysian LNG*
Main contractor: *Japan Gasoline Co + Pullmann Kellogg*
Sub contractor: *Toyo Kanetsu*
Starting date: *1982*

One of the most advanced designs of LNG storage tanks uses a 9 % Nickel-steel inner tank surrounded by an independant concrete confinement wall and an earthen berm as shown in fig 1. It is known as the «double-integrity» concept.

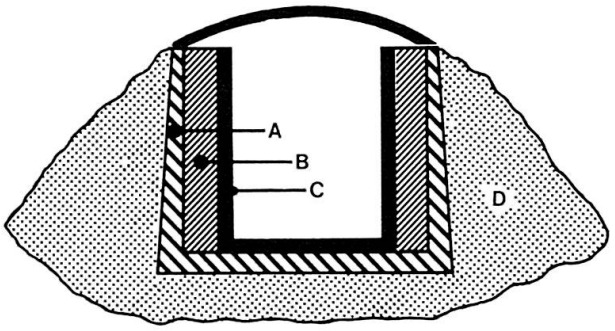
The secundary containment of such a configuration may be subjected to high peak stresses under low temperature conditions in case of an accident, as the event of a partial or total failure (zip-up) of the inner tank cannot be excluded.

Is is well known that for standard reinforcing steels as used in day-to-day jobs toughness and ductility deteriorate with decreasing test temperature to a point where brittle failure will occur.

The concrete reinforcing steels for low temperature applications must therefore, in addition to the normal range of properties which characterize standard reinforcing steels, maintain a high level of ductility or toughness reserve at the low design temperature.

Recent specifications for concrete reinforcing bars used in LNG storage tanks require:
- an adequate yield-point level in combination with a minimum elongation on notched tensile specimens tested at the design temperature, if the designer expects static load conditions

or
- an adequate yield-point level in combination with a minimum Charpy-V notch toughness at design temperature, if dynamic loading is expected.



A: Concrete reinforcement walls
B: Insulation
C: 9 % Ni steel tank
D: Earthen berm

Fig.1 LNG-Storage Tank

Amongst those requirements, the latter is the most stringent one and the most difficult to meet.

To satisfy such severe specifications the choice of available steel qualities is limited to Nickel-steels which normally obtain the required properties by a postrolling heat treatment consisting in a double normalization or a quenching and tempering and to austenitic steels with cryogenic properties. Both types of steel are very high-priced, due to the alloy costs and to the expensive post-rolling heat treatment.

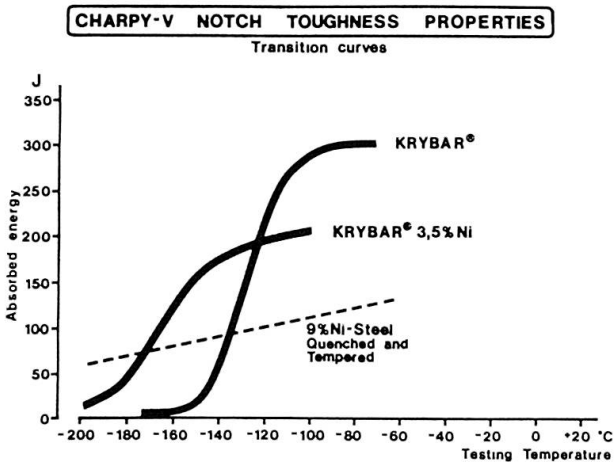
In view of this situation and considering the market needs, Arbed developed a new production process for Krysteels that match the cryogenic properties of high Nickel alloys without or with reduced Nickel content and without need for a heat treatment after rolling or after working of the steels at site. Thus significant economy can be achieved without sacrificing cryogenic performance. This new patented production method utilizes a closely controlled chemical analysis together with a special rolling technique.

This new development has resulted in the definition of 2 reinforcing steel series which meet the requirements for cryogenic applications:

Krybar with guaranteed Charpy-V notch impact properties at -120°C (-184°F).

Krybar Ni with guaranteed Charpy-V notch impact properties at -165°C (-265° F).

The results of Charpy-V notch tests, simulating dynamic load, are summarized in the following diagrams:



Since the original development, different material specifications have been drawn up to suit conditions peculiar to other projects i.e. ductility requirements on notched tensile bars at -165°C (-265°F).

(J. de la Hamette)