CSL double-articulated boom

Lassing Dibben wins Schreyer Award

Lassing Dibben Consulting Engineers Ltd. – Trenton, Ont.

Canada and the United States have developed the concept of the bulk self-unloading ship to a fine art. They lead the world in its use and development. The big advantage of this type of ship is that it requires no shore facilities and only a minimal dock to unload itself at rates up to 10,000 short tons (9100 tonnes) per hour.

The two usual methods of depositing ashore bulk materials (e.g., coal, iron ore, gypsum, crushed stone, or grain) are the shuttle and boom-supporting conveyor belts. The shuttle is generally mounted crosswise in the ship and pushed out approximately five metres to unload into an adjacent hopper on the dock. The boom, normally about 75m long and mounted on the ship's centre line, can be swung and elevated to either side to make a stockpile on the shore.

Neither arrangement is very flexible. The ship with a shuttle can only unload in ports with a suitably placed hopper, and a ship with a long boom finds it difficult to load into hoppers unfavorably positioned on the dock or into a barge alongside.

Innovative design

The double-articulated boom designed by Lassing Dibben Consulting Engineers Ltd., for Canada Steamship Lines Inc., overcomes these disadvantages and has proven to be the most flexible unloading system to date.

Installed on a ship, the ocean-going boom can reach its full length to make a stockpile 60m ashore; load into a hopper placed almost anywhere on the dock; reach down into a barge alongside; or reach between the legs of a clamshell ship-unloader to discharge into its unloading hopper. In fact, it can almost load coal into the ship's own funnel.

In configuration it is essentially a 30m-long boom, mounted on the end of a 46m-long boom, supporting 1600mm-wide conveyor belts. Designed and built in Canada, the boom was shipped for installation to Brazil where the CSL Innovator was retrofitted. Transporting the boom was a challenge, but the bigger challenges, by far, were confronted in the design stage of the project.

A major concern was the inboard boom which was not to twist more than 1.5 degrees when the outboard boom was slewed 90 degrees because the conveyor belts would not run true. This was resolved by making the boom of two large box girders (1350mm x 2200mm x 12mm thick) plus many cross-box girders. The maximum angle of twist was calculated to be 1.25 degrees. In trials it was measured to be about one degree.

Another problem was that the articulating section had to remain with one degree of a horizontal plane, regardless of the inboard boom elevation, to keep the slewing drives of the outboard boom to a reasonable size and to keep the outer boom belt running true.

The solution devised was to support the articulating section on trunnions on either side at the end of the inboard boom; a third point of support is a 500mm-diameter hydraulic cylinder that works in tension or compression as required to keep the articulating section level. This cylinder operates regardless of the angle of the inboard boom and is controlled by the use of a pendulum switch mounted on the articulating section. The outboard boom is suspended from a 2.5m-diameter slewing ring and gear.

The transfer of bulk material at the articulating section, from one belt to the other was potentially a serious problem because if material were to land off centre on the outboard boom, the belt would run off to one side. This problem was further complicated because depending on what the ship is carrying, the incoming stream of material can enter at an elevation of zero to 18 degrees and the outboard boom can be slewed to ± 150 degrees or elevated from -15 to $+18$ degrees.

To overcome this situation, the head pulley of the inboard boom conveyor was placed on the same centre line as the trunnions. This means that as the boom is elevated, the pulley is at least at a constant position relative to the articulating section. A nine-faceted baffleplate was placed inside the chute so that material hitting it at any angle (between 0-18°) is deflected vertically downward through the vertical slewing axis. A turnhead spout mounted on the outboard boom collects this flow and guides it in the direction the boom is slewed.

Made in Canada

With the apparatus' infinite range of operating positions, its static and dynamic loads and the clearance studies required, designing the boom was a complex task. At sea, for example, the parked boom must be able to withstand storms during which a ship can roll up to 30 degrees each side and experiences vertical, horizontal, and lateral acceleration forces, hogging and sagging.

Built at the Malton, Ont. plant of John T. Hepburn, Limited, the boom was hauled in sections to the Port of Toronto then transported by ship to Brazil for installation. The CSL Innovator returned to Canada carrying Brazilian iron ore, which was unloaded without a hitch at Quebec City, Oct. 9, 1988. The ship is now being used extensively in European waters.

Patented by Canada Steamship Lines, the double-articulated boom designed by Lassing Dibben attests not only to the ingenuity of Canadian consulting engineers, but also to the great value of clients with the courage and commitment to sponsor innovation. ■