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S/S Cairn Glen

St. Regt. No 29393

Rule Dimensions - 400' x 55' x 37' 25" to upper Deck.

(F.E.)

Class - 100 A1 with preboard.

Owners - Cairn Line of Steamships Ltd

Built by - Messrs Wm Pakersgill & Sons Ltd in 1926.

Observations made of the ^{Straining} ~~behaviour~~ of the Ship's Structure during the Voyage Middlesbrough - Montreal - Newcastle-on-Tyne

Outward Passage

The Ship left Middlesbrough on April 16th in a partially loaded condition. The Cargo Consisted mainly of Steel plates, galvanized iron Sheets, ammonia, rolls of burlap etc. Particulars of the Loading are shown on Print I Fig 6.

The mean draught on Sailing was 17'-3 $\frac{1}{2}$ ", the Maximum Summer draught of the Ship being 25'-6 $\frac{3}{4}$ ".

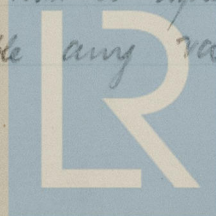
The outward passage was good, no very severe weather being encountered.

On this occasion all the holds were accessible, the Cargo being disposed so as to leave the Sides of the Ship clear to allow of observations of the behaviour of the framing being made.

Wires approximately parallel to the inner edges of the frames were arranged on each side of the Ship in the holds, and also in the deep tanks where the small quantity of water it contained was pumped out, for the purpose of measuring the transverse movement of the framing. The wires were kept taut by means of tightening screws at their lower ends.

The disposition and arrangement of these wires are shown on Print I Figs 1 & 2.

Diagonal wires were also fitted in each of the above compartments extending from the bridge to a third deck beam knee on the opposite side of the Ship, with a tightening screw and steel string at one end to enable any warping movement to



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be recorded.

Measurements of the transverse movement of the framing were frequently made during the passage at three equidistant points on each wire, the elongation of the racking wire springs being also noted.

The results of these observations and extracts from the Ships log regarding the weather, speed of the ship and revolutions of the engines during the passage are shown on front I Tables 1 & 2. The transverse movements of the framing as given in the Tables are those at the middle of the length of the wires, this in all cases being approximately twice the movement at points a quarter of the length of the wire from each end.

The maximum recorded movements of the framing in each hold and in the deep tanks are as follows:—

	Transverse Movement of framing	Movement Length of frame *
N ^o 1 Hold	$\frac{1}{8}$ inch	$\frac{1}{1690}$
" 2 "	$\frac{5}{32}$ "	$\frac{1}{1200}$
Deep tanks	$\frac{3}{64}$ "	$\frac{1}{3730}$
" 4 Hold	$\frac{3}{32}$ "	$\frac{1}{1940}$
" 5 "	$\frac{9}{32}$ "	$\frac{1}{830}$

* The length of frame is taken from the top of the tank side bracket to the bottom of the beam knee plus 2 feet.

The racking movement of the ship was found to be very small, the elongation of the racking wire spring in no case exceeding $\frac{1}{32}$ inch.

In the forward half of N^o 2 Hold on the Starboard side about 15 rivets attaching the frames to the shell plating above the bilge were found to be started and in some cases leaking slightly. In the same vicinity the second seam of shell plating above the bilge showed signs of slight leakage in places.

The time taken for each of the above movements (Zero-Maximum-Zero) was from 6-17 seconds



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For defects in Nos 1 and 5 Holds see ~~the~~ report on observations made during the previous voyage. Leith - Portland - Newcastle. The leakage in No 5 hold on the present occasion was less than previously reported.

No other defects in the structure in addition to those previously reported were observed during this passage. It may be remembered however that a small fracture in the girder above the upper deck connecting the side of the bunkers hatchway to the forward end of the boiler casing on both sides of the ship, has on some previous occasion been repaired by the fitting of a doubling plate.

An extensometer designed and made in this office and slightly adjusted on the ship to suit the conditions prevailing thereon, was used during the passage for obtaining the range of strain in various parts of the structure.

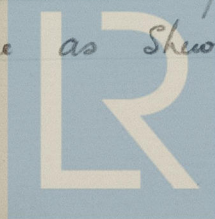
A sketch of the extensometer, showing the method of attachment to the ship is given on Print II and the positions in which the instrument was fixed are shown on Print I Figs 1 & 3.

The extensometer recorded a magnification of 2.41 of the actual elongation and contraction of the structure over a distance of $26\frac{3}{8}$ "

From the readings thus obtained the range of stress has been calculated from the formula $E = \frac{\text{Stress}}{\text{Strain}}$ the results being shown on Print I Table 4. When the extensometer was in position the pointer was in constant motion and it was only possible to obtain the range or variation of the stress and not the actual stress. To obtain the actual stress approximately half the range of stress should be added or deducted from the stress prevailing in still water.

It was also thought that it would be of value to obtain the range of stress over a somewhat greater distance than was possible with the extensometer referred to above and for this purpose a contrivance as shown on Print I Fig 5

a photograph showing it in position is attached



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was arranged on the face of the upper deck girder abreast the Bunkers Hatch about amidships, the distance over which the range of extension and contraction of the structure was measured in this case being 13'-6". The range of stress calculated from the readings thus recorded are shown on Print I Table 4.

To test the accuracy of the two methods the small extensometer was also fixed to the upper deck girder and it was found that the range of strain obtained in each case were in practical agreement.

The maximum range of stress obtained during this passage was 4.1 tons with the extensometer fixed to the upper deck stringer plate amidships (Position C).

It was also the intention ~~to~~ to obtain data regarding the lengths of waves but owing to the confused state of the sea, this was only possible on April 21st when the length of wave was approximately 200 feet.

While the Ship was at Montreal

The ship arrived at Montreal on April 28th and during the time she was at this port the reduction in deflection of the framing in the holds due to unloading was recorded the results being shown on Print I Tables 1 and 2.

In the Engine and Boiler space the increase in deflection of the framing due to loading was recorded the results being shown on Print I Table 3.

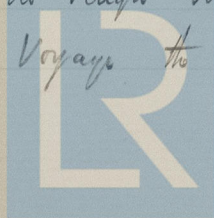
Homeward Passage

The ship left Montreal on April 4th and arrived at Newcastle on April 15th nearly fully loaded with grain in bulk, flour in bags and general cargo.

The mean draught was 24'-5".

The passage was fine no rough weather being encountered. As during the previous voyage the behaviour of the

The stresses in the upper deck stringer plate about amidships on the port side (Position D) were always more than in the corresponding position on the starboard side (Position E). This is thought to be accounted for by the fact that the stringer plate on the port side is joined for an air pipe between the extensometer position and the ship's side thus causing a concentration of stress in this vicinity.



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Structure in the engine and boiler spaces was carefully observed. The arrangement of wires for measuring movement of framing & stringers is shown on Print I Figs 1, 2 & 4

A diagonal racking wire was also arranged in the engine space extending from a tank side bracket to a 2nd deck beam wire on the opposite side of the ship

The recorded transverse movement of the framing and stringers together with extracts from the ship's log regarding the weather, speed, and revolutions of the engines are shown on Print I Table 3

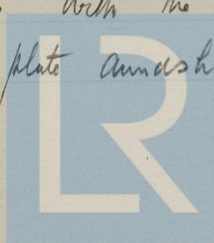
The maximum measured movements of the framing and stringers are as follows:—

	Maximum Measured Movement	Approx. Corrected Movement after allowing for Movement of Stringer	Corrected Movement Length of frame or stringer
Engine Room Framing (Port Side)	$\frac{1}{16}$		$\frac{1}{2770}$
Engine Room Framing (Starboard Side)	$\frac{3}{32}$	$\frac{3}{32} - (\frac{1}{32} \times \frac{1}{2}) = \frac{5}{64}$	$\frac{1}{2220}$
Boiler Room Framing	$\frac{1}{16}$	$\frac{1}{16} + (\frac{1}{32} \times \frac{1}{2}) = \frac{5}{64}$	$\frac{1}{2220}$
Engine Room Stringer (Starboard Side)	$\frac{1}{32}$		NA
Boiler Room Stringer (Port Side)	$\frac{1}{32}$		NA

The time taken for each of the above movements was from 6 to 7 seconds.

For defects in the engine and boiler space see report on previous voyage. The movements of the feed heater and evaporator seating were not so great on this occasion as previously reported.

The range of longitudinal extension and contraction of the structure in various parts of the vessel was recorded as during the outward passage and the corresponding calculated ranges of stress are shown on Print I Table 5. The maximum range of stress obtained during this passage was .92 tons with the extensometer fixed to the upper deck stringer plate amidships (Position II)



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The after peak above the tunnel recess was examined and no defects additional to those previously reported were found. Owing to the vessel not pitching as much as during the previous passage the leakage in the after peak clear of the tank was less on the present occasion.

The fore peak, Shelter Deck, Deckhouses, Casings and tunnel were examined and found to be in order.

Conclusions regarding observations made during the Voyage

N ^o 8 Hold	} See previous report as the weather conditions were slightly more severe during that voyage.
Engine and Boiler space	
Bulwarks	
After peak	

N^o 1 Hold The recorded maximum movement of the framing is not considered to be excessive and the slight defects in this hold are considered not to be due to weakness of the structure.

N^o 2 Hold The recorded maximum movement of the framing is thought to be somewhat excessive. ~~the~~ The defects in this hold in view of being on the Starboard side only may have been caused through touching quay walls. The vessel is stated, lies Starboard side to the quay at Louth, Montreal and Newcastle.

Deep Tank

The movements of the framing are small, this probably being accounted for by the fact that the frames are bulb angles 10½ deep and of greater strength and stiffness than those in the engine and boiler room and the holds clear of the ice strengthening. No defects were found in this tank.

No 14 Hold

The Maximum Movement of the framing is not excessive and no defects were found.

Longitudinal Stress

The range of Stress obtained from the use of the extensometer was in no case excessive. The results however are considered of value in so far as they show the actual variation in the range of Stress throughout the length of the Ship. The range of Stress in the upper deck Stringer plate at the half length forward and aft was found in no case to exceed half the range amidships.

Bounding

During the outward passage the Ship occasionally "bounded". When this took place the impact of the Vessel with the Sea was accompanied by a loud report and relatively violent longitudinal "quivering" of the Structure. This "quivering" motion was more severe when bounding took place than at any other time during the voyage. It is suggested that this sudden impact of the forward part of the Vessel with the Water, when in the lightly or partially loaded condition, will produce a high stress in the Structure amidships and is possibly a ^{Contributory} Cause of ~~these cases~~ of damage to the strength deck at the forward end of the boiler casing, in Ships partially loaded, which is sometimes reported.



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