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Why the Titanic did not list

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NS 415 Titanic
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The list of any ship is due to either a negative initial stability (GM, metacentric height) or off center weight. So the list is due to internal force. Off center weight is due to poor loading of cargo, unequal amounts on each side. Negative initial stability occurs when the center of gravity (G) is higher than the Metacenter (M), ($KG \geq KM$).

Since the Titanic was a passenger ship designed especially for immigrant business, the ship's officers and crews paid much attention to provide a comfortable ride for the passengers during the ship's voyage, therefore stowed cargo for a small GM. The ship must have an inclinometer to indicate her list, so engineers will trim the coal bunker equally between bunkers to achieve the goal. Normally, officers like the GM to be about 2% of the beam of a passenger ship.

According to the cargo plans, all weights of cargo were low down and evenly distributed throughout width of the ship. There wasn't any major cargo in the ship except the coal, the water ballast and the fresh water. Most of the rich people had some of their luggage in their stateroom's the rest was down in the hold. The total baggage's weight was 900 long tons. The cargo's weight wasn't enough to be a big factor in the stability of the ship.

The times and list are approximate and based on survivor's testimonies. It should be noted that as the ship gained flooding water, the GM (metacentric height) increased due to weight added low in the hull. When Boiler Room No.5

WHY THE TITANIC DID NOT LIST

flooded, there was a pronounced change due to increased breadth at free surface, the center of gravity started moving up. The GM began to decrease and with that there was a dramatic decrease in the range of stability. According to analysis study of the damage done by Navel Architects and Marine Engineers, the damaged area was estimated to be 12-plus square foot, As the flooding rate increased, the range of stability also decreased, reflecting the fact that the fore deck was submerged and that the transverse metacenter was decreasing also.

The next table is a summary of the flooding, Draft, Trim, GM, Range of Stability, and List as function of time, taken from the book *Titanic ships, Titanic Disasters*, page 251

Time	Floodin g water (Tons)	Mean Draft (Feet)	Trim By Bow (Feet)	GM (Feet)	Range of stability (Degree s)	List (Degree s)
11:50 pm	3975	34.6	9.38	1.77	97.4	5 (stbd)
12:00 am	7450	36.58	21.69	2.44	96.1	?
12:30 am	14131	40.29	41.90	3.17	85.0	?
1:10 am	23607	45.25	66.71	4.88	77.8	1.0(port)
1:20 am	26438	46.85	75.88	3.29	76.7	?
1:50 am	32741	58.46	141.08	1.60	63.1	2.1(port)
2:00 am	35312	78.88	247.77	0.12	16.3	?
2:20 am	39542	SINKS	-	-	-	-

The above table shows that The Titanic did not experience any negative GM

During the early stage of the sinking just after striking the iceberg, as the ship's hull opened to the sea the water flooded the Starboard side of the affected hold up to the level of the top of the fireman's passage. Thus causing a small list due to off-center weights. Thus the ship's center of gravity moved transversely, leading to the list of the ship until the ship's center of buoyancy moves an equilibrium position under the center of gravity.

Flooding water has a free surface, if the hold has small transverse extent, the effect will be small since the free surface effect depends on the breadth of flooded compartment. When the liquid moves from one side to side, the center of gravity of the liquid will move toward the listed side, this is called virtual rise of the center of gravity. Thus the greater the permeability of the surface of the flooded water, the greater the virtual rise of the center of gravity. The free surface effects of the flooded area will cause the vessel's center of gravity to rise, which will lead to a reduced initial stability (GM).

. The initial starboard list was due to flooding starboard side of firemen's passage in cargo hold No.2 and 3. The firemen's passage had a height of 10.5 feet in the center of both holds No.2 and 3, which caused the starboard list for a short period of time due to unsymmetrical flood. Therefore when the height of water in the second and third cargo hold became more than 10.5 feet the list disappears due to flooding in port side which allowed the crew to launch the lifeboats without any difficulty due to list.

“ During the final stage of the of the flooding, when the ship sank deeper into the water, the stability curves, produced by Hackett and Bedford [5] indicate that the ship had much greater sensitivity to list from

shifting weight such as passengers moving from one side to the other.”

Titanic, the anatomy of a disaster.

Titanic did not have any longitudinal bulkheads, this allowed symmetrical flooding across the width of the ship. The longitudinal bulkheads would prevent such a thing but would cause a great degree of list due to off center weights and would need to be corrected quickly otherwise the degree of the list would increase. All these analysis study for the accident prove that the ice cube tray effect was what really happened. The ice cube tray effect explains that transverse bulkheads were not high enough to prevent the water from flooding to next compartment.

Reference:

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- 2- La Dage, John and Lee Van Gemert. Stability and Trim for the Ship's Officer. Cornell Maritime press. Maryland. 1983. Third Edition.
- 2- Grazke, Jr, William H. & John Woodward, Titanic ships, Titanic Disaster, the Society of navel Architects and Marine Engineers, 2002
- 3- Titanic, the Anatomy of a Disaster: A Report from Marine Forensic Panel (SD-7).” The Society of Naval Architects and Marine Engineers Preprints, 1997
- 4- Original Deck Plans.