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DIGITAL METHOD FOR REFLOATING A SHIP STRANDING DURING TRANSIT SUEZ CANAL USING ITS OWN MEANS

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1. ABSTRACT:

Emergency situations strike unexpectedly and prevent the vessel from completing the voyage to transit the Suez Canal. Predict a system for emergency response in Suez Canal become a necessary step to protect the navigation against unexpected action SCERS supports and enables quick actions to mitigate the effect of the incident. The ability to respond immediately to an emergency on the vessels during transit SC and plan for the quickest return to normal operation. The main core of this research is studying the possibility of digital refloating the stranded ship case during transit Suez Canal by its own means using a preliminary trim control step considering Suez Canal applying the ship emergency response system with a proactive step always working in positive active mood to cover Suez Canal. The constrain is the preliminary trim control step not affected the ship maneuvering capability during transit Suez Canal.

This will be achieved through the following strategies:

Focus on the Suez Canal main items (Suez Canal characteristics. operation system, transit regulation, weather, current, types of sea bed, last year's ship stranding cases)

Explain the methods for ground reaction calculation of stranding ship and the effect of refloating the stranded ship tugs bollard pull.

Demonstrate the digital emergency response system as the result of". OPA'90 case study for VLCC ship during transit Suez Canal The analyses before and after VLCC trim control using ballast to prove that the trim control method can use a quick emergency response action to refloat stranding ship advancing in Suez Canal with its own means in typical stranding case by using digital commercial software HECSALV.

Keywords: STRANDING, EMERGENCY RESPONSE SYSTEM, REFLOATING STRANDING SHIP WITH ITS OWN MEANS.

2. INTRODUCTION:

The Suez Canal considers one of the main navigation ways 12 % from international trading pass through it., the ship transit Suez Canal in a time period from 12 to 16 hours. The Suez Canal daily capacity 76 standard ships and increased to 97 after opening new Suez Canal. Emergency situations strike unexpectedly and prevent the vessel from completing the voyage to transit the Suez Canal. Predict a system for emergency response in Suez Canal become A necessary step to protect the navigation against unexpected action SCERS supports and enables quick actions to mitigate the effect of the incident. The ability to respond immediately to an emergency on the vessels during transit SC and plan for the quickest return to normal operation. Attention to the ISM Code – Emergency Preparedness. Part of SOPEP and Vessel Response Plan. Evidence of an active approach and commitment to safety and the environment. Assistance in “Managing risk”. For oil tankers, oil barges and FPSOs transit the Suez Canal. SCERS ensures compliance with mandatory requirement of MARPOL Annex I, Ch.5, Reg.37(4), requiring “oil tankers have to involve in land-based calculation programs for damage stability and structural strength”. OPA’90 and 33CFR155.240 conditions are met program provides the necessary technical support required in the critical hours after a vessel is stranded. SCERS consists of data base contain electronic model to all the vessels transit SC before the Convoy sailing SCERS team enter the loading case to the electronic model which prepared using commercial software HECSALV or equivalent and also trim control by define the amount and position for adding water ballast according to stability and strength calculation as advanced step for refloating the grounded ship in Suez canal using her own means in case of vessel stranding .during the Convoy sailing SCERS team observe the position of each vessel and ready to immediately take action according to the emergency situations.
This paper aims to investigate possibility of refloating the stranded ship case during transit Suez Canal by its own means using SCERS in the positive active mood with proactive step by ballasting fore peak tank before transit SC with always trim aft this technic in the typical Suez Canal stranding. considering Suez Canal applying the ship emergency response system to cover Suez Canal. (Authority SC (2019))

3. BACKGROUND:

a stranded ship is subject to very different combined forces buoyancy and ground reaction equal to the total ship weight, she is in a critical position because she is affected by force distribution according to the stranding case not the same in normal service. In all cases, fast action for refloating the ship from dangerous situation, for reducing stress in the hull and high risk of pollution.

Varsami et al. studied refloating a bulk carrier ship using the combined effect of the main engine in different levels and directions of speed and ballasting/de-ballasting the ship to minimums the bow draft in order to reduce the pressure from the ship hull on the sea bottom (Varsami, A., 2012).

A. Suez Canal Characteristics:

The Canal seafloor types change according to the position, through soils of silt and clay sedimentations deposited in the north and this formation extends 40 km to the south of Port Said. The intermediate region of the Canal starting from Kantara to Kabret is combined of fine and coarse sands, while the south part consists of dispersed layers of rocks, containing mixture from soft sand and some calcium rocks. The extreme tidal range in Suez Canal is varying from 65 cm in the north to1.9 m in the south. The bank gradient of the water cross section is 3:1 in the south and 4:1 in the north.

B. OPERATION in SUEZ CANAL:

For free double-lane flow, the channel is too narrow. The ships, thus, travel through convoys, using bypasses. Out of 193 km (120 mil), the double passes are increased in all (50%) after opening new Suez Canal project in 2015. The new Suez Canal increased the standard ships ability from 76 to 97 standard ships can pass the canal in 24 hours and also decrease the ship normally transits the canal form18 to 11 hours.

As free two-way traffic not permitted in the canal, all ships transit regularly in convoy lines. It scheduled for a scheme of 24 hours. A single convoy begins from Suez at 6 a.m. every day. At 6 a.m. This convoy transported unhindered. It uses the eastern path. Two southbound convoys interwoven in the northbound journey of this caravan. The first begins in the north at 0.00 o'clock from PORT SAID, with the big bitter lake anchoring. The second southbound convoy begins at 07.00 hours from Port Said with anchors to make the northbound convoy go via the west bypass of Ballah. This convoy has smaller and often unloaded ships.

C. EFFECT OF ACCIDENT ON CONVOY SAILING:

According to Suez Canal characteristics any kind of accident (Fire-Collision /Grounding with Major leakage or spillage of oil cargo) during the Convoy sailing especially at a single lane of traffic can stop the navigation partially or completely so the time become very important factor for dealing with the accident.

I. SHIPPING ACCIDENTS:

In 2004, The grounding case oil tanker AL SAMIDOON incident occurred in the Suez Canal. As a result, oil spill containing about 9,000 tons of crude oil which is moved with the effect of high current. The Suez Canal emergency plan for control oil spill was been activated, using booms, skimmers and dispersants. The slicks drifted to the north in the direction of Mediterranean Sea as sheens and tar-balls (Dewina & Yamauchi, 2009).

On February 26, 2006, the oil tanker "GRIGOROUSSA" ran aground at Suez Canal, leaked 2,700 tons of oil and polluted 8 miles of coastline.

On March 23, 2021, the Container ship "EVER GIVEN" ran aground at Suez Canal, lodging herself against both banks of the waterway. The period of six days, the salvage team from Suez Canal Authority (SCA) consists of more than 11 tugs and 2 dredgers cooperate with international salvage company to start salvage plan as a combined of dredging to remove the ground under the ship hull and using the tugs bollard pull to return the ship to the deep water.

D. CONTANGANCY PLAN IN SUEZ CANAL:

The Suez Canal Authority (SCA) For Several years has been establishing measures to respond within its jurisdiction to oil pollution incidents. to ensure the procedures and activities of the authority are in accordance with the national contingency plan for the oil spill, the EEAA will collaborate together with the SCA to develop a written emergency plan for the pollution of oils.

Responsibility for oil spill inside the Suez Canal remains with the Suez Canal authority in compliance with its mandate. (ABD El-GeliL. I (1998)).

The pollution control plan aims to define procedures and responsibilities in the event of a fuel spill. The Suez Canal Authority not involved in emergency response system to dial with ship stranding during transit SC specially in the single pass.

4. Calculating of Ground Reaction:

A. Methods of Calculating Ground Reaction:

B. Nomenclature	
R	The ground reaction force
W_i	Total ship weight before grounding
W_a	Total ship weight. After grounding
T fa	forward Draft before grounding
T fs	forward Draft after grounding
D_f	Distance.from. the.forward perpendicular.to. the.center.of.flotation
d_r	Distance. Between. the centers .of ground reaction.and . flotation
L	Length.between perpendicular
$T_{m.bs}$	Draft at midship before grounding.
$T_{m.as}$	Draft at midship after grounding.
TPI	The mass in tons. Required for immersion 1 inch.
t	total trim in inches.
MTI	Moment required to increase trim one inch.
LCF	The center of ship area at waterline.
dr	The Distance between centers. of ground reaction.and LCF
Dn	Distance from the LCF to the NP
Dnr	The Distance between NP and dr
B	Buoyancy
NP	The Neutral Loading Point
SCERS	Suez Canal emergency response system
VLCC	Ship type very large crude oil carrier.

Table 1: Intact Trim and Stability summary

No.	Method	Formula
1-	Change.of Displacement Method	$R = W_i - W_a$
2-	Change.of. Forward Draft Method	$R = \frac{(TPI) \times (MTI) \times (L) \times (Tfa - Tfs)}{(MTI \times L) + (dr \times df \times TPI)}$
3-	Tons.per.Inch.Immersion Method.	$R = (T_{m.bs} - T_{m.as}) \times TPI$
4-	The change of trim method	$R = \frac{MTI \times t}{dr}$

• All methods give results that are approximate.
• Ground reaction had to be calculated by two methods and the results should be close.
• The methods of change in forward draft method and in displacement method can be used in all stranding cases.

C. . EFFECT OF WEIGHT CHANGES ON GROUND REACTION:

Effect of Weight Changes on Ground Reaction in the Stranded ships depend on the position of the weight decreasing the ground reaction and increasing the buoyancy force.

D. THE NEUTRAL LOADING POINT:

The neutral loading point is a point in the stranded ship at which adding or removing weight without any change in the ground reaction; In addition, at that point the parallel sinkage due to weight addition equal the change of trim. Figure 1 shows the location of the points required to determine of the neutral loading point location.

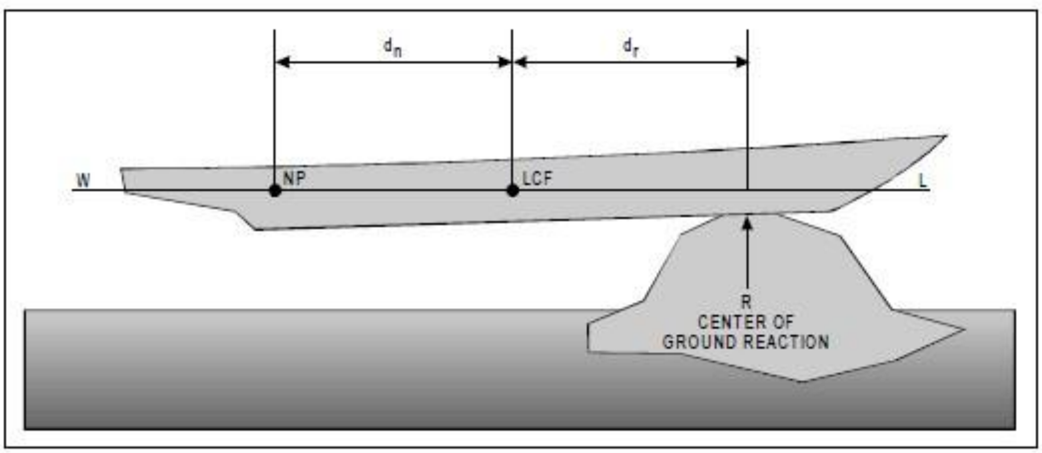


Figure 1: Typical ship stranding case during transit SC and Locate the Neutral Loading Point

E. Effects of Weight Changes on Ground Reaction:

Figure 2 show that in case of removing weight forward of the neutral loading point decreasing the ground reaction while adding weight forward of the neutral loading point decreasing the ground reaction. The NP will be off the ship if the distance between center of the ground reaction and the center of flotation is less than L/8, and the ship stranded along its length.

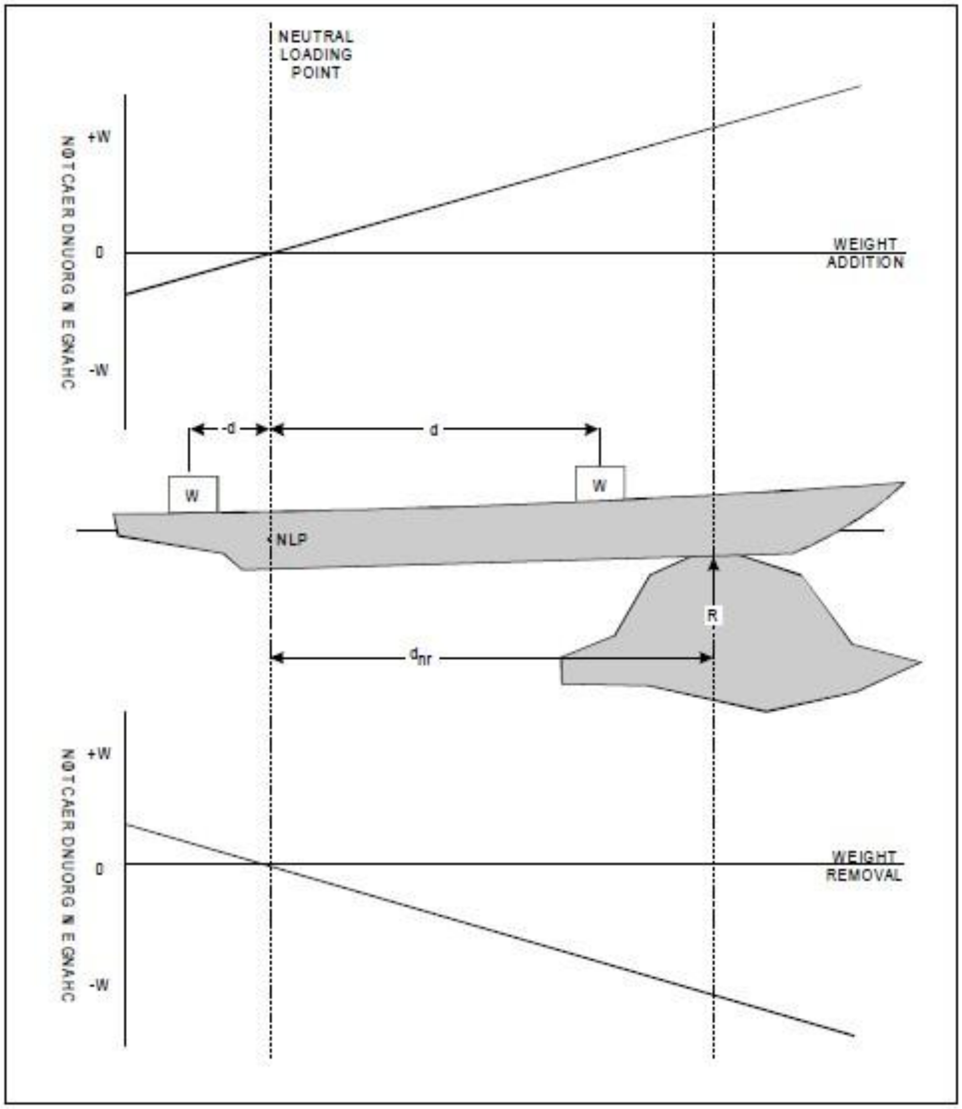


Figure 2: Effects of Weight Changes on Ground Reaction

F. THE TUG BOLLARD BULL:

The tug Bollard bull (F) is the puling force needed to free the ship from shallow water in short tons can be calculated by multiplying coefficient of friction(μ) by the ground reaction(R) .

$$F = 1.12 \times \mu \times R$$

Coefficient of static friction (μ) depend on the type of seafloor for mud Silty soil or Silty soil 0.2 to 0.3 while Sand from 0.3 to 0.4 and coral from 0.3 to 0.4 but it increased from 0.8 to 1.5 for rocky seafloor. (NAVSEA (S0300-A6-MAN-010), 2006:)

5. DIGITAL SHIP EMERGENCY RESPONSE SYSTEM (ERS) A.

ERS OVERVIEW

ERS enables fast action around the clock by the land base access specialist teams of naval architects, salvage experts and ship master are ready to introduce advice immediately after receiving the data check list from the stranded ship master. The team used software tool containing, pre-prepared ship model for the stranded ship. The first step enters the actual loading case before stranding, the next step enters the loading case after stranding according the information sent from stranded ship master and simulate the stranding case. Finally send the advice with the salvage plan to the ship master. In case of external support is needed the advice is sent to the ship by steps to control the situation until the external support can be mobilized.

ERS REGULATION REQUIREMENTS

ERS complies with the following regulations and industry guidelines:

- MARPOL 73/78 Annex I, Regulation 37 and MARPOL Regulation 1/37(4), as which state that ship must have digital land-based programs for calculation damage stability and residual structural strength.
- Requirements of OPA 90 in 33 CFR 155.240.
- IACS Rec. No. 145 and ISM Code, Section 8, which requires the ship operator to establish procedures to respond to potential emergency shipboard situations, including the use of drills and exercises to ready for emergencies.
- The Guidelines OCIMF on Capabilities of Emergency Response Providers.

B. SOFTWARE TOOLS:

HECSALV commercial software used in this study as example. Is enable a simulation of stranding ship, it enables good analyses for the ship stranding situation. It simulates salvage plan steps for refloating a stranded vessel. Software tools capability including simulation for ground reactions, Tank damage, Tide-level-change and oil out flow calculation :

Many software tools used by ERS the worldwide used:

1-HECSALV 2-GHS

CASE STUDY

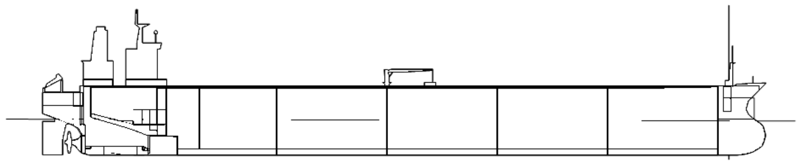
REFLOATING VLCC STRANDING DURING TRANSIT SUZE CANAL WITH ITS OWN MEANS

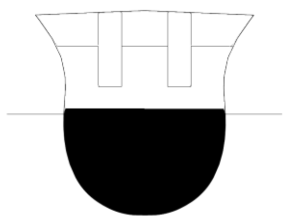
Assumption that;

1-Suez Canal (SC) using Emergency Response system (ERS) and already have prepared model for all tanker transit SC using HECSALV commercial software.

2- SC using ERS in the active mood by enter the actual loading condition for the tanker before enter SC using HECSALV model. (Tidal and current positive or negative effect are not considered in this case study)

3- SC using ERS in the active Positive Action mood for tanker by ballast fore peak water ballast tank just before transit SC with condition final trim aft.





Ship particular

LOA m 333.227 LBP m 318.000

Depth m 31.250 Beam m 58.000

Initial Loading case before stranding

TFP 16.012m TAP 16.795m Light ship 40,853tons

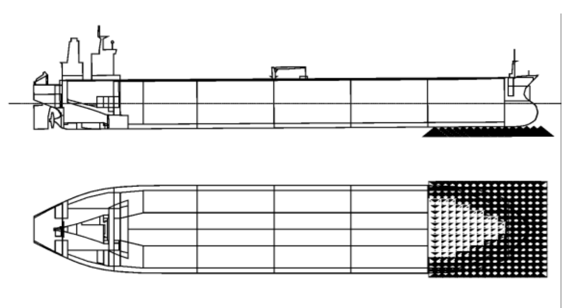
Displacement 245,383 tons Cargo Oil 194,577 tons

fore peak tank (4,855tons, LCG 152.867 f M.S.)

TPC 165.2 Ton MMIC 3500 t .m LCF 6.293 m M.S.

Case 1 Stranding as typical SC Stranding case (stranding fore part at side bank)

Summary	Value
T M.S before Stranding	16.403m
T M.S after Stranding	16.179m
Total reaction (R)	3699 MT
LCR	48.7A m.FP
TCR	0.47S m.CL
Force to free	5,549 MT
Friction Coeff.	1.5



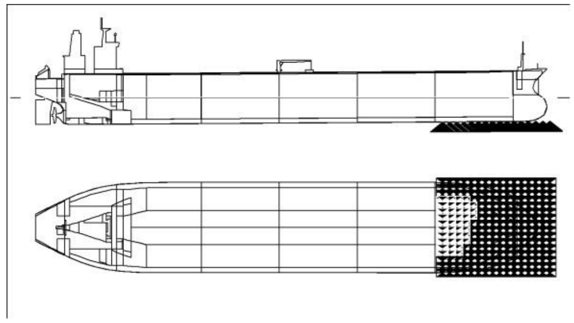
In this case de-ballasting fore peak tank is enough to refloat the ship with condition:

TFP 14.728 m TAP 17.557 m Trim 2.828 m

Shear force (SF) 31% Bending Moment (BM) 38% GMt 10.182 m

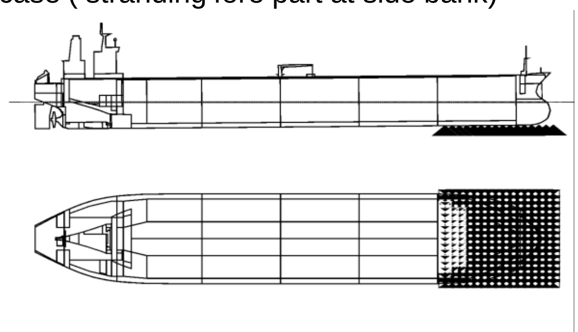
Case 2 Stranding as typical SC Stranding case (stranding fore part at side bank)

Summary	Value
T M.S before Stranding	16.406m
T M.S after Stranding	16.101m
Total reaction (R)	5136 MT
LCR	56.67A m.FP
TCR	2.95P m.CL
Force to free	7,704 MT



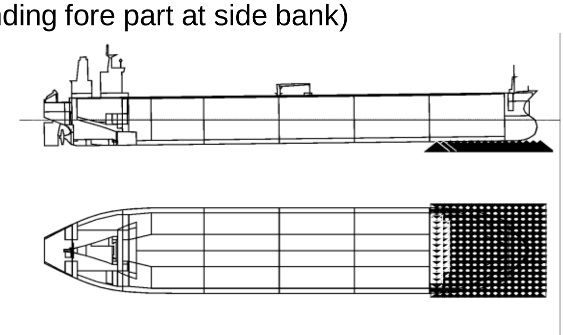
In this case de-ballasting fore peak tank is enough to refloat the ship.
TFP 14.728 m TAP 17.557 m Trim 2.828 m
Shear force (SF) 31% Bending Moment (BM) 38% GMt 10.182 m
Case 3 Stranding as typical SC Stranding case (stranding fore part at side bank)

Summary	Value
T M.S before Stranding	16.406m
T M.S after Stranding	16.044m
Total reaction (R)	6506 MT
LCR	56.950 m.FP
TCR	0.264S m.CL
Force to free	9,759 MT



Step 1: de-ballasting fore peak tank reduce ground reaction from (6506) MT to (343) MT
(trial by using main engine power at Astern dead slow speed to free from the ground)
Step 2 : ballasting aft peak tank 50% (1033) MT the ship is free floating wih final drafts:
TFP 14.570 m TAP 17.852 m Trim 3.282 m
SF 32% BM 48% GMt 12.183 m
Case 4 Stranding as typical SC Stranding case (stranding fore part at side bank)

Summary	Value
T M.S before Stranding	16.406m
T M.S after Stranding	15.818m
Total reaction (R)	10,569 MT
LCR	58.026 m.FP
TCR	4.393P m.CL
Force to free	15,854 MT



Step 1: de-ballasting fore peak tank reduces ground reaction from (10,569) MT to (4,423) MT
Step 2: ballasting aft peak tank 100% (2066) MT reduce ground reaction from (4,423) MT to (3,475) MT.
Step 3: Transfer cargo oil from NO 1 COC tank (4880) MT LCG (118.723 F m-M. S) to slope tank P& slope tank SB each (2440) MT LCG (100.288 A m-M. S). Reducing ground reaction from (3,475) MT to (68) MT.
(trial by using main engine power at Astern dead slow speed to free from the ground)
TFP 12.998 m TAP 19.614 m Trim 6.615 m

SF 29% BM 53% GMt 11.9 m
Step 4: Ballast NO.5 WBT P&SB tank (2100) MT each with total amount (2100) MT to free the ship from grounding with final:
TFP 12.998 m TAP 19.614 m Trim 6.615 m
SF 29% BM 53% GMt 11.9 m

Summary:

The analysis of the results in the case study shows that in the typical Suez Canal stranding case with the fore part on the side bank, the ballasting fore peak tank (4855) tons in that case before transit SC as a proactive step in the Suez Canal Emergency Response system is equivalent to tug boat bollard pull 6200 ton. At that typical stranding case the first action has been taken de ballast fore peak tank after survey the stranding condition. In the case NO (1) and NO (2) with ground reaction (R) (3,699&5136) MT empty fore peak tank is enough for refloating the vessel while case NO (3) which more grounding with (R) (6506) MT is remaining (343) MT ground reaction in order to refloat the vessel Ballast aft peak tank 50% (1033) MT the ship free floating. The ground reaction in the case NO (4) reduced from (10,569) MT to (4,423) MT after de ballast fore peak tank. Ballast aft peak tank 100% (2066) MT in order to reduce ground reaction from (4,423) MT to (3,475) MT the next step Transfer cargo oil from NO 1 COC tank (4880) MT LCG (118.723 F m-M. S) to slope tank P& slope tank SB each (2440) MT LCG (100.288 A m-M. S). Reducing ground reaction from (3,475) MT to (68) MT which overcome with ship power. In all the previous cases the strength and stability calculation were in the normal range.

6. Conclusion:

Predict a system for emergency response in Suez Canal become A necessary step to keep the safe navigation all the time against unexpected action. Enable Suez Canal authority from containment of any kind of crisis in a shortest period. SCERS work in operational positive active mode with proactive action through the following steps:

1- Data base consists of digital model for all Ships transit SC approved from classification societies linked with land-based calculation programs for damage stability and residual structural strength with operational team work around the clock (HECSALV program Software Tools was an example in case study).

2- SCERS in the active mood by enter the actual loading condition for all ships before enter SC and define the ship position during transit SC to enable the SCERS team to identify the type of seafloor and values of current, wind, tide according to the ship position.

3- SCERS in the positive active mood with proactive step by ballasting fore peak tank before transit SC with always trim aft this technic in the typical Suez Canal stranding case with the fore part stranded on the side bank when de-ballasting 1000 ton from fore peak tank after stranding for example that equivalent to use tug with bollard pull 1500 ton in case rock seafloor or 330 ton in case of clay seafloor ready to use without losses.

4-In case of bad impact action act to stop the navigation in SC in both side due to terrorist operation or huge impact stranding ship as the case of EVER GIVEN stranding which stop the navigation for 6 days at 23, march,2021 and the situation is needed to share with international salvage companies or others partner SCERS enable to share the information and start accurate salvage plan to return the navigation in SC in shortest period.

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