الأبحاث المنشورة - (1994-2005) في مجال الطاقة والبيئة

للأستاذ الدكتور محمد عبد الفتاح شامة

Published Papers (1994-2005)

on Energy and Environmental Protection

by Prof. Dr. M. A. Shama

1- "A Projection on the Future Demands and Capability of Offshore Technology" A.M.R.J. (Egypt-1976), Shama, M. A.,. (100%)

2- "A General Outlook to Offshore Technology", Egyptian Society of Marine Engineers and Shipbuilders, Forth seminar, Alexandria, April, (Egypt-1983), Shama, M. A., (100%)

3- "Costs of C02 Abatement in Egypt Using Both Bottom-Up and Top-Down Appr", Energy Policy, (USA-1994)Yehia El Mahgary, A. F. Ibrahim, M. A. F. Shama, A. Hassan, M. A. H. Rifai, M. Selim, I. Abdel Gelil, H. Kokor, Anhar Hegazi, A. Amin, F. Bedewi and Juha Forsstrom, (8%)

4- "Estimation of GHG Emissions in Egypt Up to the year 2020", World Resource Review, Vol. 6, No. 8, (USA-1994), Yehia El Mahgary, VTT-Energy, A. I. Abdel-Fattah, M. A. Shama, Alexandria, Faculty of Eng., M. Selim, I. Abdel Gelil, Anhar Hegazi, NREA, Egypt, M. A. Rifai, Azhar University, A. Amin, F. Bedewi EEA, Egypt, and J. Forsstrom, (11%)

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8- "GHG Emissions Inventory for Egypt and Emission Mitigation Options",VTT, Energy, (Filand-1995), Yehia El Mahgary, VTT-Energy, Finland, M. A. Shama, A. F. Ibrahim and A. Hassan, Alex. University, Egypt, M. A. Rifai, Azhar University, Egypt, I. Abdel Gelil, M. Selim and H. Kokor, ECPO, Egypt, Anhar Hegazi, NREA, Egypt, A. Amin, F. Bedewi EEAA, Egypt, and Juha Forsstrom, VTT-ENERGY,Finland, (8%)

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14- "Life Cycle Assessment of Ships", IMAM 05, Sept. International Maritime Association of Mediterranean Sea, (Portugal-2005), Shama, M. A. (100%)

15- "Environmental Dimension in the Ship's Life Cycle", MARDACON 9, December, Int. Con. "Towards a Cleaner and Safer Maritime Context", (Egypt-2005), Shama, M. A. (100%)

SHIP CASUALTIES; TYPES, CAUSES AND ENVIRONMENTAL IMPACTS

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ABSTRACT

The main objective of the paper is to highlight the impact of ship casualties on marine pollution, to examine the role of the human factor in promoting ship structural damages and casualties and to clarify the main direct and indirect causes of ship casualties. The paper, therefore, gives an overview of the different types and causes of ship casualties. The impact of environmental conditions, technical deficiencies and human errors on the type and rate of ship casualties are especially considered. Some statistics of these casualties are presented. It is shown that collisions, groundlings, fire and explosions are the most frequent types of ship casualties. The distribution of the annual rates of structural damages due to the different types of ship collisions are also given. The various direct and indirect causes of ship structural damages due to heavy weather are indicated. A typical distribution of ship casualties after one year service is presented. The distribution of corrosion failures among the different deck structural elements is presented. The distribution of the annual rate of damages to the main structural elements of cargo ships, oil tankers and bulk carriers are given. The annual rate of damage to the bottom shell structure, side shell structure, transverse bulkheads and longitudinal bulkheads in the midships region of oil tankers due to the various causes are given. Particular emphasis is placed on the distribution of the annual rate of wear and tear among the different main structural elements of oil tankers. It is evident that inspection, maintenance and repair play a major role in promoting ship casualties and therefore impairing the marine environment. Adequate measures and efforts should, therefore, be directed to reduce all possible ship technical deficiencies and to eliminate / reduce all expected human errors in the various stages of ship design, construction, operation, inspection, maintenance and repair.

Keywords: Casualties, Structural failures, Marine pollution, Environmental impacts, Human errors.

INTRODUCTION

Ship structural failures and casualties represent main causes of marine pollution. It is , therefore,necessary to identify the main types and causes of ship accidents and casualties in order to eliminate/ minimize the harmful impact of these accidents on the marine environment. The main environmental impact of marine casualties is marine pollution, mainly oil pollution. The scope and scale of the marine pollution hazard depends a great deal on the type and nature of the marine casualty and the type and size of the ships involved in the casualty. For oil tankers, the scope of marine pollution is extensive, whereas for small cargo ships and service crafts, the scope of marine pollution is rather limited.

One of the main causes of these accidents and casualties is the human factor. Human errors involved in these accidents, directly or indirectly, are numerous. Identification and analysis of the types and causes of these human errors are, therefore, essential elements of the measures needed to reduce/eliminate the hazards of marine pollution. This requires a full understanding of the main types and causes of ship casualties and their direct or indirect relation with the causing human errors. The statistical data presented in this paper are obtained from several sources and references, a list of which is given at the end of the paper. These data are not the most recent ones, but could be updated when more recent data are available.

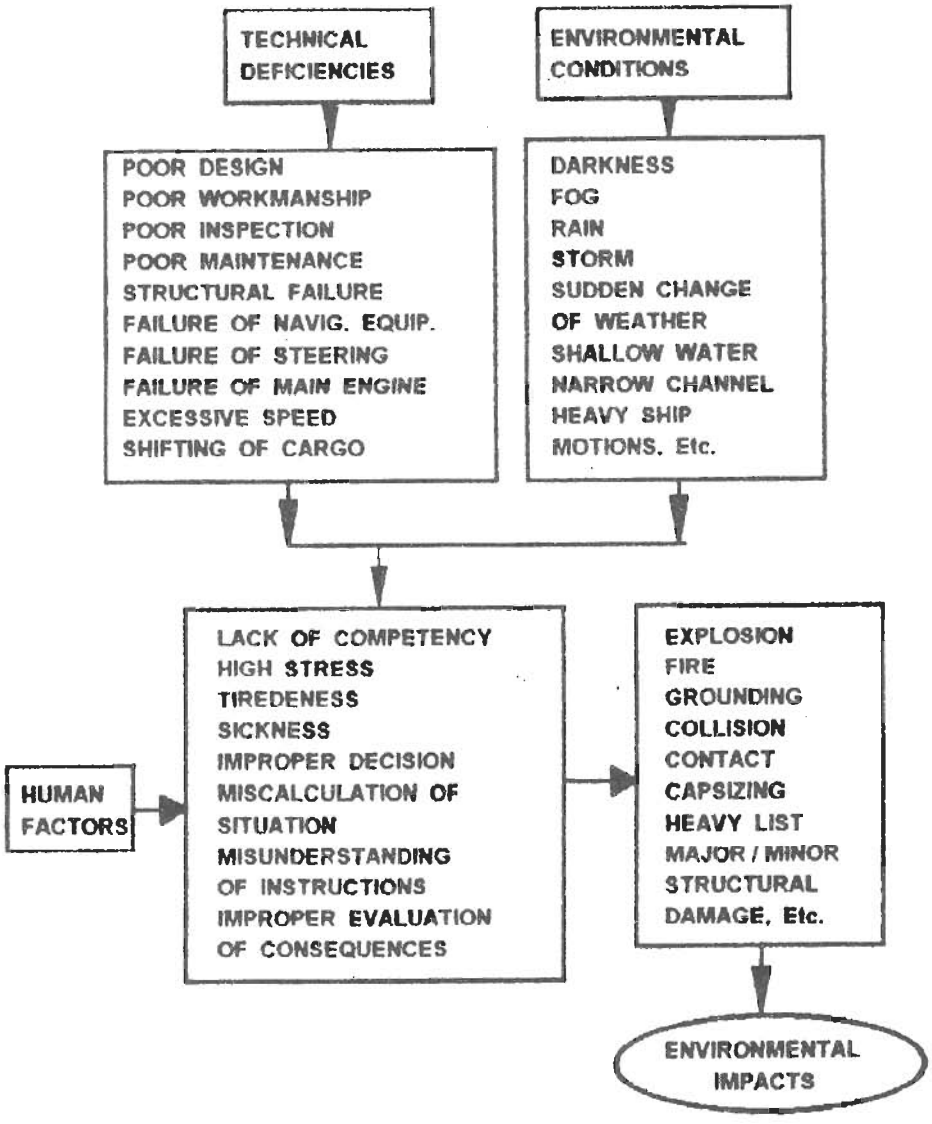

Figure 1. Nature and causes of casualties.

Nature, Rate and Causes of Ship Casualties

Ship casualties, such as structural damages, fires, explosions, capsizing, etc., may be attributed to human errors, random errors, environmental conditions or technical deficiencies. The failure of different parts of a marine structure has usually quite different consequences in terms of casualties and economy. Figure (1) illustrates the nature and main causes of these casualties. The distribution of some of the main causes of ship casualties are shown in Table (1). It is evident from Table (1) that violations against rules and poor look out are serious causes of ship casualties. Figure (2) shows the statistics of the main causes of these casualties .It is clear from Figure (2) that collisions, fire and groundlings represent major causes of ship casualties.

The distribution of the rates of the main causes of annual losses of ships less than 5 years old and of ships aging between 20 and 25 years are shown in

Table (2). It is shown that ship wreck, foundering, fire and explosions are the main causes of ship casualties. It is clear from Table (2) that the distribution and rates of the different causes of ship casualties differ significantly with ship's age.

Ship structural damages are considered one of the main outcomes of many types of ship casualties. The

Table 1. Distribution Of Main Causes Of Casualties.

Violation Against Rules	27%
Poor Look Out	22%
Poor Machinery Maintenance	13%
Poor Position Fixing	4%
Faulty Aids To Navigation	4%
Violation Against Watch Duties	4%
Poor Ship Handling	4%
Others	22%

Table 2. Main Causes And Rates Of Annual Losses Of Ships

Ship Age	Less Than 5 Years	20 - 25 Years
Foundering	41%	28%
Wrecked	21%	37%
Fire / Explosion	13%	24%
Collision	21%	8%
Others	4%	3%

main causes of structural damages due to the various types of collisions, heavy weather and groundlings are shown in Figure (3). It is clear that collisions with port installations and with vessels along side, in addition to heavy weather, are the main causes of ship structural damages. The direct and indirect causes of structural damages due to heavy weather are shown in Figure (4) for the main structural parts of a ship. The common damages due to heavy weather include:

- bottom damage caused by slamming
- bow damage due to pounding or panting
- damage to deck, girders, beams, pillars, hatch-coamings, deckhouses, etc., due to shipping green seas.
- Damage to masts, rails, bulwarks, deckhouses due to severe rolling motions and shipping green seas
- Damage to the aft end structure due to high vibration stresses.

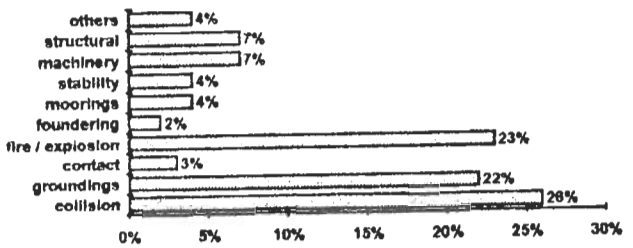

Figure 2. Distribution of main vessel Casualties.

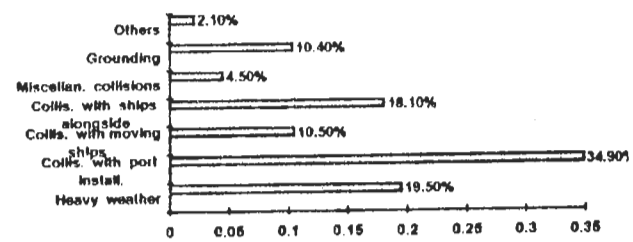

Figure 3. Main causes of ship Structural damages.

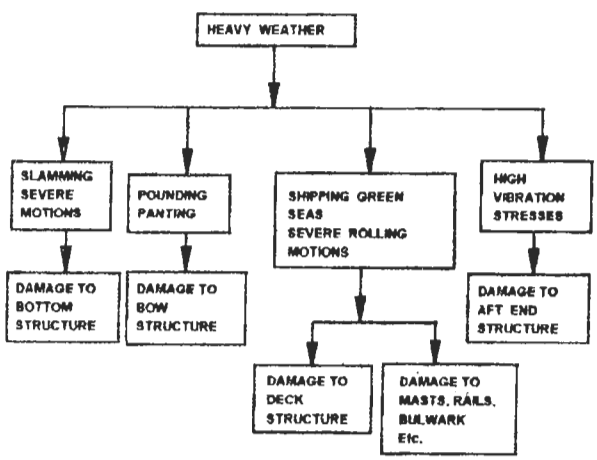

Figure 4. Heavy weather damages.

The annual rate of damage to the fore end structure due to the various causes is shown in Figure (5). It is clear from Figure (5) that a high percentage of the damage and failure of the fore end structure result from unknown causes.

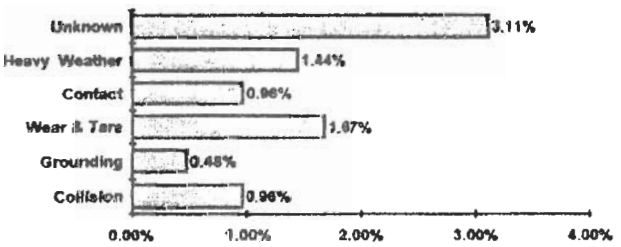

Figure 5. Annual rate of damage of the fore end structure.

The main ship casualties after one year service is shown in Figure (6-a). The ship casualties, after one year service, due to severe accidents, is shown in Figure (6-b). It is shown that hull failures represent 13.8% of the total causes of severe accidents after one year service. Figure (6-b) shows also the types and distribution of severe accidents after one year service. Figure (6-c) shows the main types of hull failures after one year service. It is shown that ship structural failures represent 54% of all hull failures after one year service. Figure (6-d) shows that ship holds and bulkheads share 36% of these structural failures. Ship sides and bottom structure represent also main structural elements subjected to high rates of structural damages and failures after one year service. It is also shown that navigation, loss of stability fire and explosions are major elements of ship casualties after one year service.

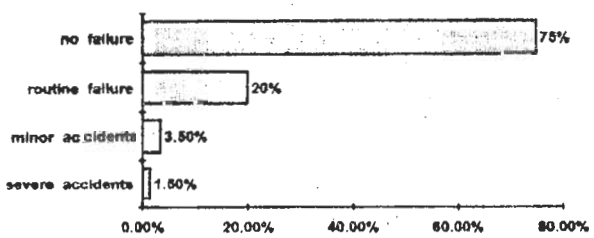

Figure 6-a. Ship casualties after one year service

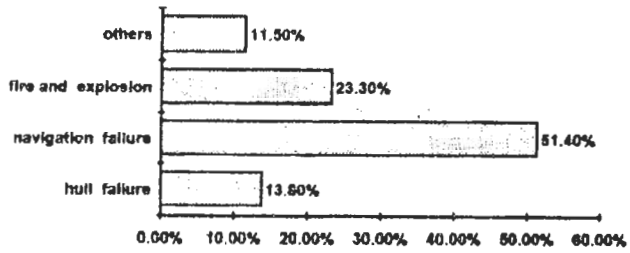

Figure 6-b. Severe accidents after one year service.

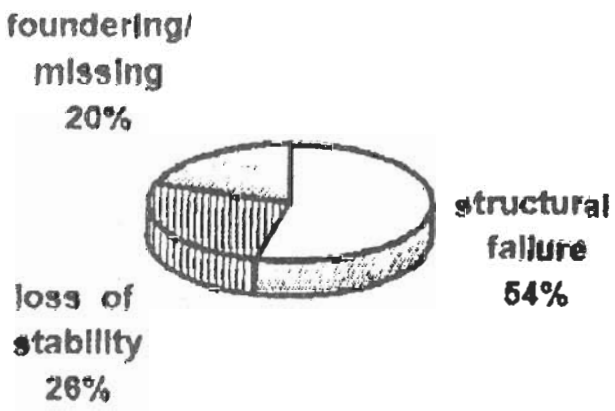

Figure 6-c. Hull failures after one year service.

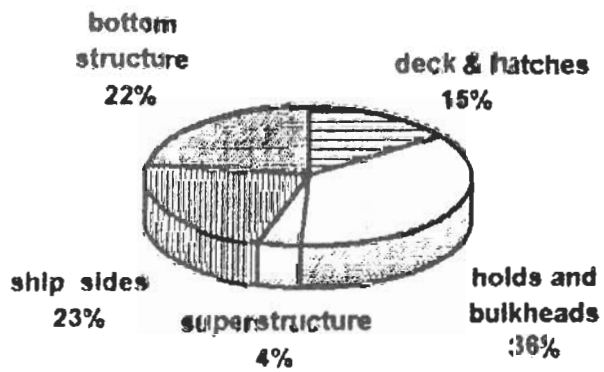

Figure 6-d. Ship structural failures after one year service.

Many ship structural damages of unknown causes are actually due to the combined effects of heavy weather, overload, underdesign, poor workmanship, wear and tear, corrosion or vibration. Figure(7) shows that corrosion could represent a major cause of ship structural failures.

Corrosion results basically from age, inadequate maintenance, chemical or corrosive action of the

cargoes carried, local wear, some improper features of design of structural details, etc. Deck plating comprises a highly stressed portion of the hull girder. Accelerated corrosion of the deck may be expected because it is subjected to mechanical abuse from deck cargo, frequent washing, etc. The distribution of structural failures due to corrosion over the deck structure of cargo ships is shown in Figure (8).

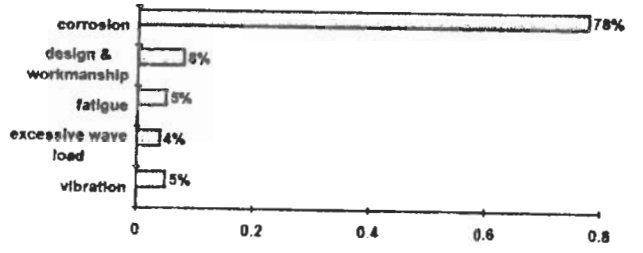

Figure 7. Main causes of hull structural failures.

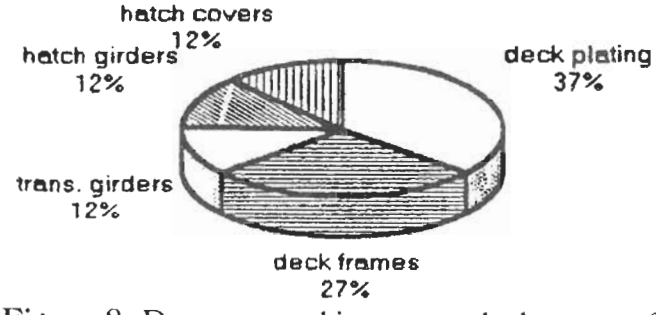

Figure 8. Damages to ship structural elements of general cargo ships.

Failures Induced By Human And Random Errors

Many aspects of ship design, construction, operation, inspection, maintenance and repair are heavily influenced by human judgement and associated possible errors. Human errors, like random errors, could result in various types and grades of failures with varying consequences. Figure (9) illustrates the various sources of human and random errors and the corresponding various consequences, as related to ship casualties and failures of ship structures. The involvement of the human factors in accidents could be categorized as follows, see Figure (1):

- Wrong decisions taken on a miscalculated risk
- Human errors in design: inadequate specifications of load and safety factors, etc.
- Human errors in fabrication: high residual stresses, large distortions, welding defects,etc.
- Human errors in operation: ignorance, incomplete knowledge, forgetfulness, etc.
- Unknown causes: organizational errors due to deficient communications, undefined responsibilities,
- inadequate motivation, poor social conditions, poor working environment, etc.

Distribution Of Annual Rate Of Damage

The distribution of the annual rate of damages to the main ship structural elements of general cargo ships, oil tankers and bulk carriers are shown in Figures (10,11,12). The distribution of the main causes of structural damage and failures to the midship region in way of cargo tanks of oil tankers is shown in Figure (13). It is clear that a high proportion of these structural damages results from unknown causes. Excessive pressure represents the second main cause of structural failures in the midships region. It is also clear that the bottom transverses, transverse bulkhead girders and the vertical webs of longitudinal bulkheads are the main structural elements of oil tankers subjected to damages or structural failures.

The distribution of the main causes and the annual rates of damages to the bottom structure in the midships region is shown in Figure (14). It is clear that wear and tear represents a major cause of failure of the bottom structure. A high proportion of the bottom damages results from unknown causes. The main causes and the annual rate of damages to the side shell structure in the midships region is shown in Figure (15). It is clear that a high proportion of side shell damages and failures results from several unspecified causes. Figure (16) shows the main causes and the annual rate of damages and failures to transverse bulkheads in the midships region. Figure (17) shows the main causes and the annual rates of damages and failures of longitudinal bulkheads in the midship region. A high proportion of the damages and failures to transverse and longitudinal bulkhead structures results from unknown causes. It is clear that wear and tare could represent a main factor contributing to structural damages and failures of the main structural elements of the midship region, see Figure (18).

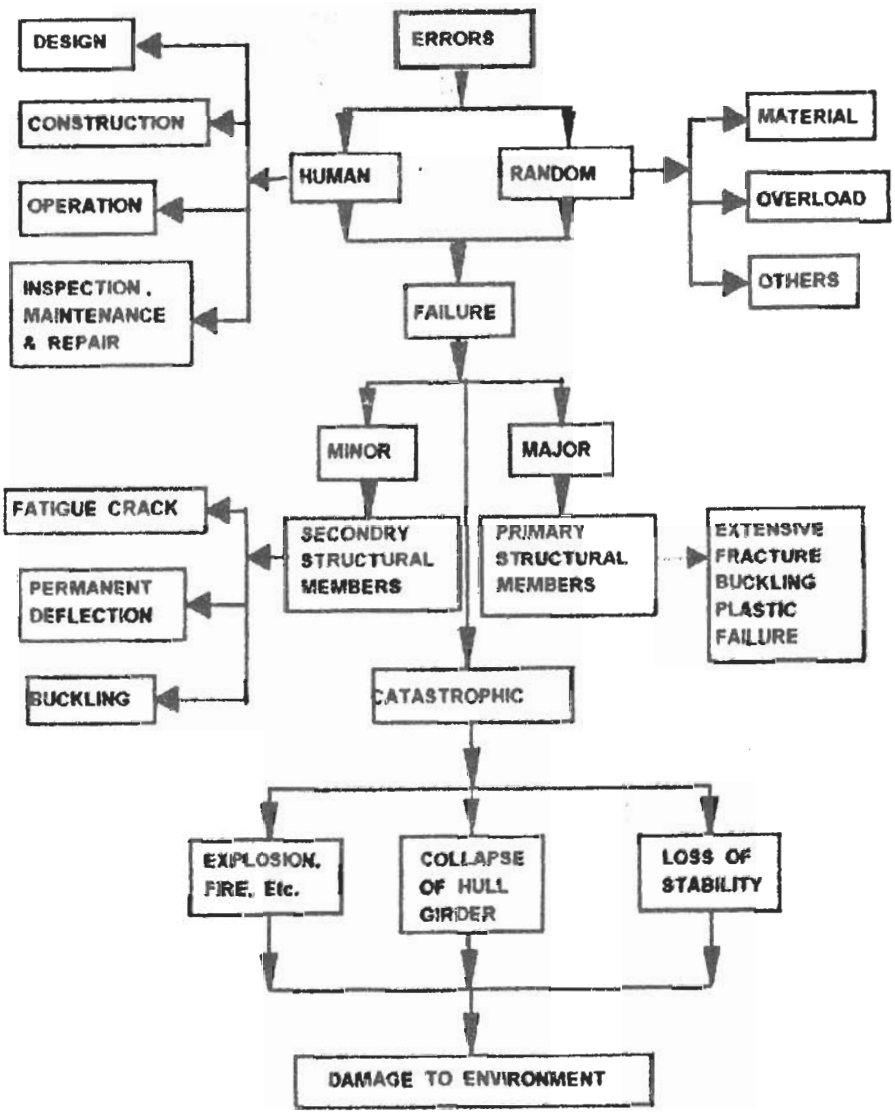

Figure 9. Consequences of human and random errors.

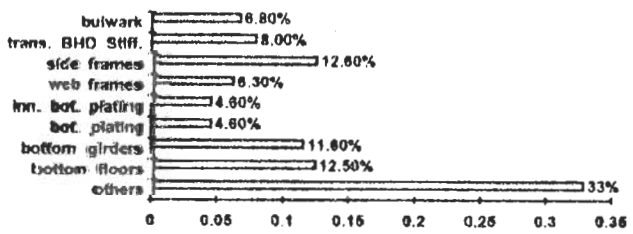

Figure 10. Damages of ship structural elements of general cargo ships.

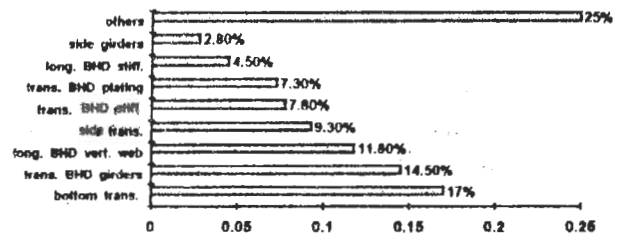

Figure 11. Damages of ship structural elements of oil tankers.

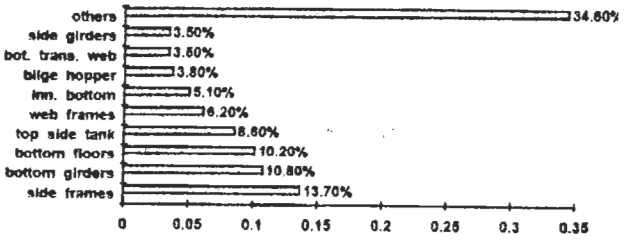

Figure 12. Damage to ship structural elements of bulk carriers.

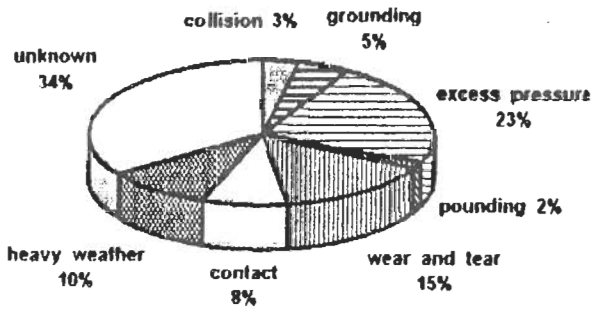

Figure 13. Annual rate of damage to the midship region.

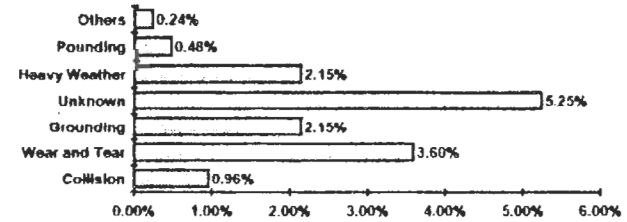

Figure 14. Annual rate of damage to the midship bottom structure.

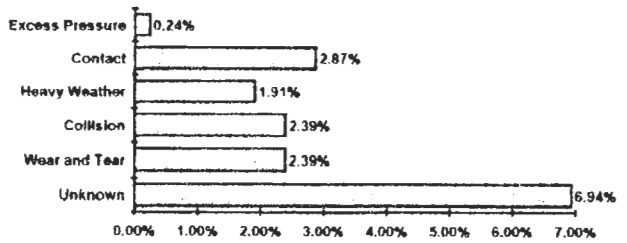

Figure 15. Annual rate of damage to the midship side structure.

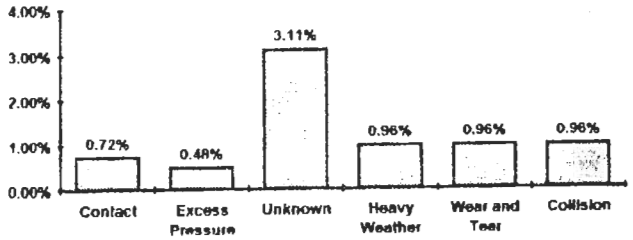

Figure 16. Annual rate of damage to the midship trans. BHD'S.

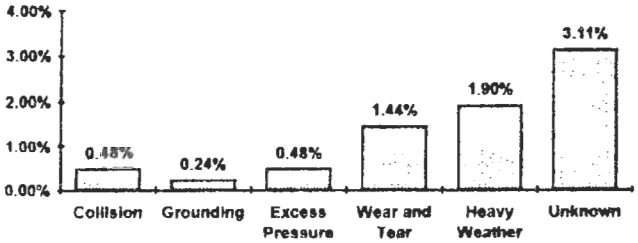

Figure 17. Annual rate of damage to the midship long. BHD's.

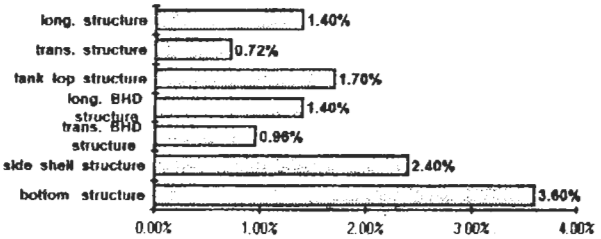

Figure 18. Annual rate of wear and tear to the midship region.

CONCLUSIONS

Ship accidents and casualties represent, directly or indirectly, the main causes of marine pollution. The identification of the main types of marine casualties and their causes should pave the way to reducing the harmful effects and impacts on the marine environment.

Ship casualties , such as explosions, fire, groundlings, collisions, capsizing, etc. result mainly from environmental conditions, technical deficiencies and human errors. The main environmental conditions participating heavily in promoting ship casualties are numerous and may include fog, storms, sudden change of weather, darkness, etc. The main elements of technical deficiencies responsible for some of the ship damages and casualties include :

poor design, poor construction, inadequate inspection, ineffective maintenance and repair work, failure of navigation equipment, failure of main engines, etc. The main human factors involved in promoting ship casualties are numerous and could include; lack of proper training and competency of the crew, overworking, high stress, tiredness, sickness, miscalculation of situations, improper evaluation of consequences, etc.

Although accidents at sea can never be eliminated completely, improved measures can reduce the rate at which they occur. It is therefore necessary to have methods for the assessment of the structural capability of damaged ships and the expected oil spill from oil tankers as a result of groundlings and collisions,

It is evident that ship casualties and marine pollution could be significantly reduced by the reduction/elimination of all the technical deficiencies and human errors at the various stages of ship design, construction, operation, inspection, maintenance and repair. This could be realized by:

- proper training and continuous upgrading of crew
- effective inspection, maintenance and repair work
- improving the working load and conditions of the crew
- maintaining ship machinery and equipment at the highest possible level compatible with economic operation
- correcting any minor structural deficiencies as soon as it is noticed, etc.

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