International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

INFLUENCE OF RESIDUAL DEFORMATION ON THE STRENGTH OF THE HULL STRUCTURE OF THE TANKER AFTER CONVERSION

R. C. Bashirov[1] & A. H. Rzayeva[2]
Department of special technology and equipment[1]
Azerbaijan Technical University[1]
Baku, Azerbaijan[1]
Department "Shipbuilding ship repair"[2]
Azerbaijan State Maritime Academy[2]
Baku, Azerbaijan[2]

DOI: 10.5281/zenodo.2549877

ABSTRACT
The paper considers the strength characteristics of the newly built and built hull structure of the tanker after conversion. The main types of deformations due to chaotically-tearing forces and compressive forces arising from the bending of the hull are revealed. The new method of welding production for installation of structural elements of double bottom and second side with geometrically calculated parameters, which allowed to reduce dangerous stresses of linear and internal character, minimized wave, deformation components, provided an increase in the moment of resistance and strength of the hull structure during operation, was applied.

KEYWORDS: shear stress, linear forces, compressive stresses, deformation moment, vertical shrinkage, permanent deformation, cracks in the liquid compound

1. INTRODUCTION
During the conversion of the oil tanker project t/x "Şamaxı" was developed and applied improved technology for the construction of the double bottom and the second side and a rational method of welding of new metal plates to the line, which resulted in indicators leading to a decrease in loads from compressive and tensile forces, with tangential and shear directions of movement, acting on the outer skin of the side in the transverse direction and along the outer skin of the bottom in the longitudinal direction, reduced wave and shrinkage deformation in the welds and along the outer skin on the surface of metal plates.

The nature of the pulse, deformation stresses arising from the longitudinal plates of the newly constructed second side and the double bottom deck is considered, their influence and load on the structural feature of the installed elements of the ship's building structure are analyzed.

The analysis showed that despite the fact that the newly installed elements of the double bottom and the second side created a certain load on the building structure [ ], the ship did not lose its seaworthiness [ ], on the contrary, the sail decreased, the stability and unsinkability of the tanker increased, the doubly - the strength of the hull structure[ ] and the resistance of the structural elements [ ], the bending moment [] is minimized.

The main reasons for the change and decrease in the strength components of welded joints of the ship's hull, the result of which is a high, uneven heating of the metal during installation and welding, which creates temperature stresses, the concentration of which is most observed on the basis of the metal sheet and rational methods to prevent their occurrence are proposed.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

The purpose of this work is to identify the effects of residual deformation on the strength of the hull structure of the tanker after the conversion and the development of technological methods to reduce their formation, taking into account the design features of the vessel, the residual thickness of the metal plates and elements of the set.
To do this, it is necessary to carry out theoretical calculations and justify the practical solutions obtained from a scientific point of view, using as a basis the available technical developments and the author's experimental research in the field of deformation stresses of local, local and natural impact on the hull structures, as well as technological developments for the repair and conversion of ships and ship technical means afloat.

2. PROBLEM STATEMENT

The hull structure of the tanker after re-equipment is considered, the technological processes leading to the appearance of residual deformation affecting the wear and stability of metal plates from bending forces, bending and bending of the vessel, components of deformation stresses when the vessel is in the cargo and empty are investigated, new technological methods for solving the tasks are developed.

3. PROBLEM SOLUTION

The analysis of the hull structure after the conversion which are constant forces and forces having an uncertain orientation and nature of education. Using practical and technological methods, the points of accumulation of "beam" deformation components leading to wear of structural elements and having the lowest resistance of plates in the area of 140 - 131 frames (engine room and Cameron's room), 131-110 frames (Cameron's room – stern cargo tank), 59 - 41 frames (the second cargo compartment of the tank №2 and the first cargo compartment of the tank №3), 41-23 frames (bow cargo tank – the second bow ballast compartment).

The obtained analysis shows that the plates and structural elements of the hull structure are subjected to uneven compression and tension during operation, which lead to the formation of residual deformations, micro and macroscopic cracks, to the rupture of the plates, "cold" (forced rupture).

The action of these forces can be classified as: shock-shock (ss), vibro-dynamic (vd), vibration-shock (vs), shock-short (ss), wave - longitudinal (wl), transverse-shock (ts), pulse (p), tangent (t) and others, which are currently due to the lack of technical base and estimates of their dimensions, not investigated and not justified.

Studies have shown that when welding of new and "old" metal plates in their welds are formed voltages, which are of uncertain impact, concentrating in the areas of fatigue fracture of metals, where there are pockets of strength, residual deformation, leading to shrinkage, undulating corrugation formations, increasing the moment of rupture of the metal structures and connections. The entire nature of the impact of non-dimensional forces on the metal structure creates additional stresses and the component of the forces of static and dynamic nature formation in the metal plates of the hull structure is enhanced after complete cooling of the welds.

Stress accumulations in welds after welding have a characteristic feature: the appearance of shrinkage and plastic deformation of residual character, wave-like corrugated elongation in the near-weld zone of welded joints of metal plates," hot " cracks of microscopic nature inside the metal plates and the set.

For their prevention have been developed rational methods for recovery of operational technological processes, increasing the criteria of the strength points in multiple points of contact in two parallel, two perpendicular to the parallel planes, which takes into account the thermal regimes of mounting, assembling, welding in the production process. If the nature of the defects identified above depends on the process, the nature and strength of the tension q will depend on $sE\sigma lvT$, equal to Q_0 , where q value depends on: k - factor of safety of plates; s - thickness of plates and set; E - elasticity of steel plates; σ - yield point of steel; l - length of span of beams reinforcing plates; v - vessel speed, T - vessel draught.

Taking these components as the main load and determining the calculated cargo pressure pc and water p_v acting on the newly installed and installation elements of the hull structure, it is necessary to take measures to reduce the impact of static forces on these structures, which will reduce the accumulation of stress in the plates and beams of the longitudinal and transverse set. But such a hypothesis about the obtained strength index of the

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

ship's hull will not fully meet the strength indicators, so it depends on several factors that do not have constant values:

- wave action of sea water on the metal plates of the outer skin, when the ship is in the cargo and empty;
- pressure of the cargo in the bending and bending of the vessel on the inner skin and the set system in cargo tanks;
- the impact of water on the bulkhead in the closed loop of the ballast compartment;
- the difference of the temperature components in carriage of oil cargo (in particular winter and summer).

Studies have shown that counteracting the forces of water and cargo plates assembled with the set are subjected to stresses creating indefinite accumulation of negative forces of compressive and tensile nature, both in the outer and inner hull plating, but according to the theory of strength and reliability of the plates: counteracting the external forces should not be accompanied by additional stress components of the moments of the forces of elasticity and stiffness of the metal circuit, otherwise such a structure will be subjected to rupture... But if we consider that due to the reduction of the impact of water and cargo forces on the hull, deformation stresses will be partially reduced, since the hull received a minimum load, then the metal hull can resist the occurrence of cyclic and linear loads, this will reduce the stress state of the plates, minimize static and dynamic stresses.

4. EXECUTION OF WORK

In order for the ship hulls to have high-quality, durable and safe structures for the carriage of goods and passengers, it is necessary to follow technical standards and comply with the technology of shipbuilding and ship repair production. But unfortunately, the currently used technologies of design and construction of ships do not fully meet the modern qualitative indicators of the strength characteristics of hull structures, which leads to a negative assessment of the quality of Assembly and welding works, and it, in turn, to the emergence of an unstable to loads "deformation-plastic" structure, which is not able to withstand the forces from the outside and inside. The conducted Assembly and Assembly and welding processes have a negative impact on the metal connection of the plates, where there are critical points, clusters of negatively charged fields affecting the welded joint in several directions, exposing it to plastic or rigid bending, deforming the metal surface doubly, increasing the tension in the welded joint and in the metal itself.

Studying these processes and identifying features of Cabinet structure against forces loaded from the hard outline, it is possible only for flat panels 6000x1500x10.0 mm and 6000x1500x12.0 mm with account for wear and residual deformation to define some component of the loads and to develop a method, warning education of the shrinkage stress and strain in nature.

After analyzing the considered component of the elastic and rigid contour forces, their influence on the installed flat plates of the double bottom and the second side of the flooring, it is proposed to calculate their bending moment, and to increase the local and longitudinal strength to apply in the construction of stiffening ribs, an equal angle having a maximum bending potential than other profiles... Used in the conversion of the tanker equal-angle square 160x160x12mm allowed to halve the bending of the hull structures, increased the resistance of the sides and the bottom, minimized the residual deformation occurring in the system, the plate – beam.

At present, the nature of residual deformations remains practically unknown, so the published scientific materials do not contain detailed data on the influence of stresses, strains, and corrosion behavior of hull steels in the construction, repair and operation of ships and ship structures. There are no specific explanations about the role of these circumstances in the design and construction of ship hulls, what are the most dangerous deformations occur before and after repair, when re-equipment, as well as what methods should be applied to reduce them. Having literary sources, these are only theoretical statements of scientists, often without concrete, practical proofs, as the nature and causes of tension in the early stages and their prevention are so diverse, and do not have dimension, how diverse the structure of defect formation.

The authors considered numerous technological materials for reducing deformation stresses and developed a new method of reducing shrinkage. We took into account the shortcomings of the welding production

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

technologies developed by other authors, proposed to improve the existing technological processes with the conduct of scientific and practical research in the field of deformation components. The indicators of wave and welding stresses arising during the casting process, then during the construction and repair of the vessel were taken as a basis.

To fully resolve them, it is necessary to constantly monitor the implementation of all technological processes of production, from the initial stage of metal melting to its application, during the construction of ships on the slipway, during repair, so on.

Proposed in the repair and modernization of vessels, timely identify negative values of thickness measurements (always occurring in the same type ships), using the technologically acceptable values. Take into account not only the process of construction of the vessel, but also its repair, in which there are Assembly and welding works, where there is an uneven one-way or two-way heating, leading to a change in the structure of the metal (figure 1).
In which case, there is tension dimensional character, strongly influencing the quality of welded joints, the strength of a newly installed installation and Cabinet design (figure 2, figure 3).

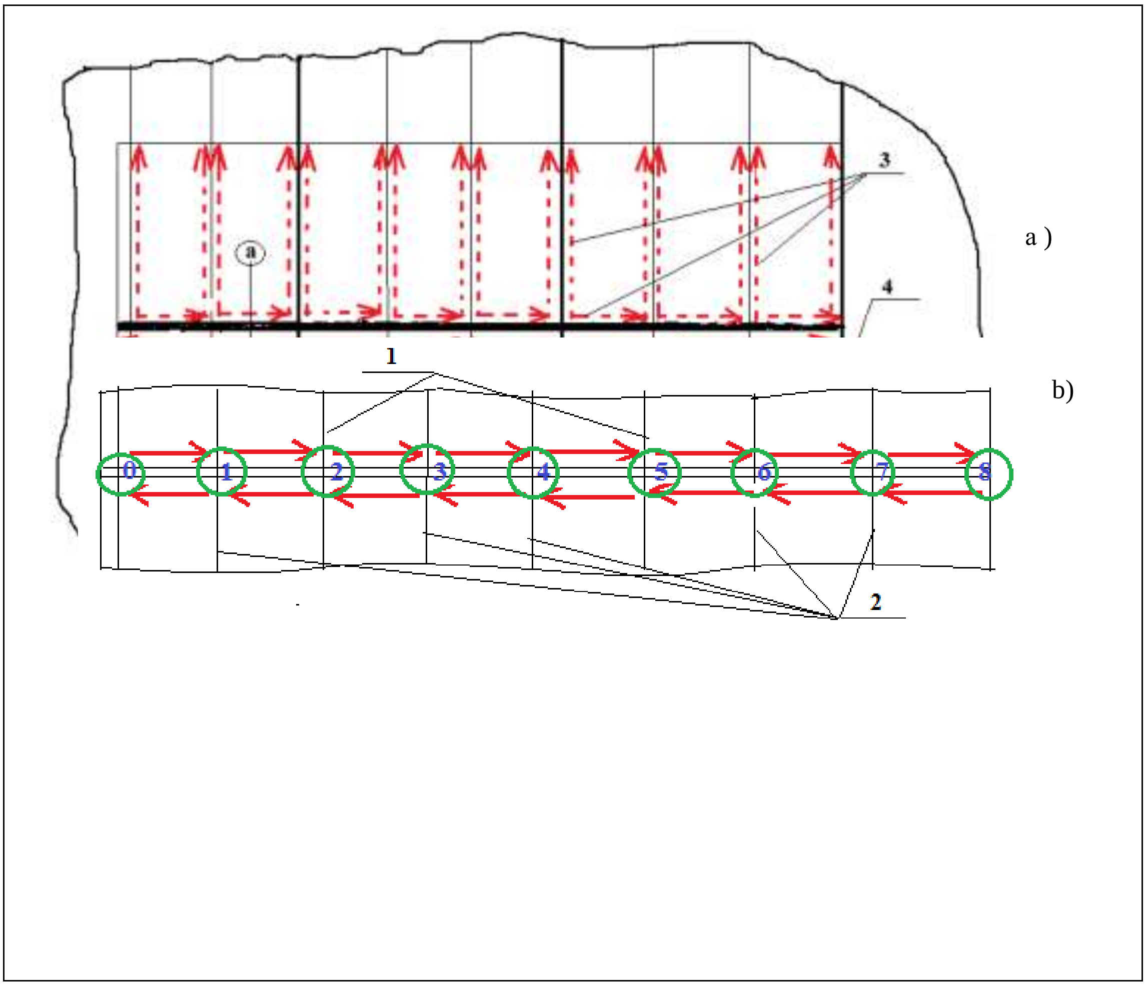

Figure 1. Scheme: welding plates of the second side

(a) -1 (a, b) – side plate; 2-the direction of welding side stringer at a height of 4550mm; 3-the direction of the welding process side frame and blank frames to the plate; 4 - the newly installed bulkhead of the second side; 5 – frame; 6 – blank frame.

(b) is a welding process of the zygomatic newly constructed side of the stringer at the height 1454 mm:
1 - braced frames; 2 - idle frames.

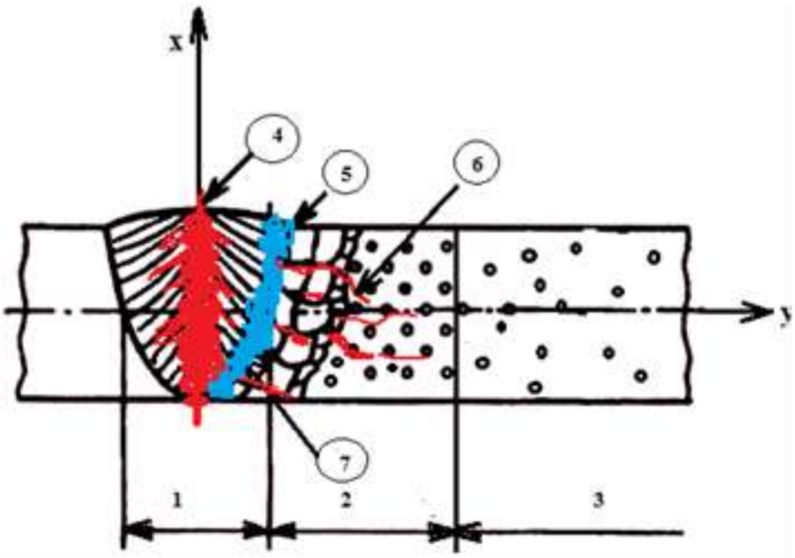

Figure 2. Schematic structure of the welding process

1-the weld pool; 2-the thermal zone; 3 - the propagation of voltage from thermal heating; 4 - the main rod of the welded process, where defects are formed; 5 - the zone of occurrence of dangerous structural faults; 6-the formation of microscopic cracks in the welding zone; 7-the transition zone from the maximum-thermal to the minimum

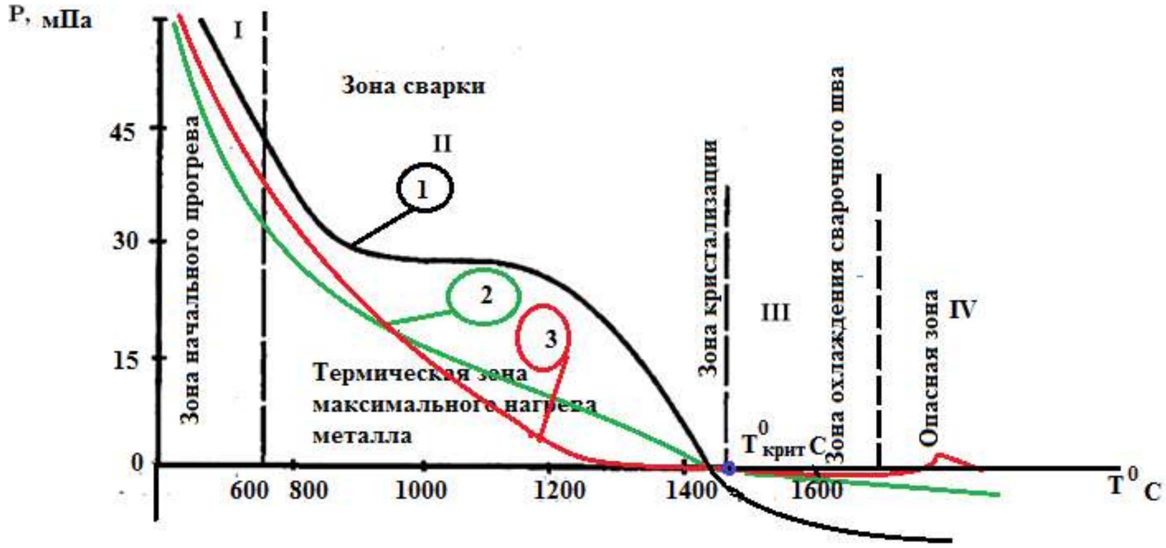

Figure 3. Temperature dependence of welding process

During operation, such stresses have a negative impact on the structural elements leading to irreparable defects in the form of: invisible, porous fistulas and microcracks; through macro-cracks "cold"; breaks in the joints and on the surface of metal plates; twisting of the hull structure (figure 4).

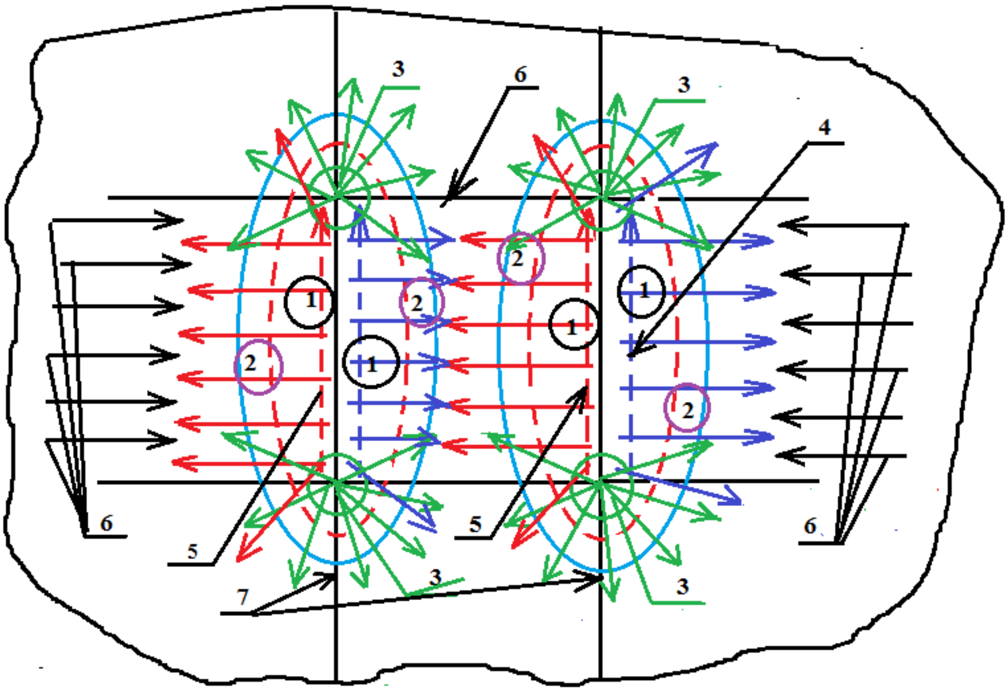

Figure 4. The scheme of modeling the components of the force stresses arising from the welding plates:

1-the direction of welding; 2-the spread of the thermal zone; 3-circular stresses arising in the butt joints;4 - the zone of the primary dangerous thermo-physical influence in welding; 5 - the zone of the secondary thermo-physical influence in welding; 6 - the zone of mixing of cold and hot flow; 7-the transverse frame set.

In order to avoid the above mentioned, defects in welded hull structures, it is proposed to comply with the operational processes of production, which will help to reduce the values of defect formation and increase the overall technical condition of the hull structure.

As a result of the work done on the refitting of the tanker, the residual character of deformation stresses was revealed and their nature was studied.

According to the practical results of the 1598r "Şamaxı", "Astara", "Gança", 1667 "Mahmud Rahimov", 1560 "General HaziAslanov" and others carried out on the t/x project, the factors of residual deformations and elastic-hard stresses on the hull during installation and welding affecting the strength characteristics of the fabricated structure and the vessel as a whole are analyzed. The analysis of the study of the welding process occurring with violations of technological standards allowed to identify the causes of the nature of cracking in the weld and in the base metal.

Analysis of the issues of wear of metal structures, suggests that the localization of local wear in certain areas of the sheet elements of the outer skin may be the result of local stresses and strains under load associated with the structural features of the body.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

According to the re-equipment technology, welding of metal sheets and assemblies requires a welding process, which is accompanied by local heating. If we take into account that a certain force is applied to the hull structure in our case, the welded force, and if this force exceeds the force acting from the hull structure of the vessel, then the shape of the installed sheet and the hull of the vessel may be certain changes in the form of deformation - "folds" corrugations. Such changes in the hull structure can lead to elastic deformation or plastic defragmentation of the plates. Here, each welded section of the hull structure assumes uneven forces that create stresses from internal and external forces, and most importantly from its own stress. Therefore, each installed structural unit on the "Şamaxı" tanker has been analyzed, calculated and prepared for installation in a regular place, in compliance with all technological norms and rules of Classification and construction of ships. It is taken into account that the structural elements are a set of ship structure, which must have strength, quality characteristics that allow the tanker to be safely operated with the greatest margin of safety.

Given that the main reason for the change and decrease in the strength characteristics of welded body structures during welding is the high heating of the metal, and the cause of the stress state of the body after welding is the occurrence of local deformation of the local character, classified as:

- temperature stresses obtained as a result of poor welding with a large difference in temperature and welding production (mode);
- own stresses arising from the violation of the welding process, leading to cracks in the weld and on the base metal. There is a need in the process of welding production and after its completion to apply the method of stress relief, which will reduce the risk of critical and reactive loads, reduce the formation of overgrown and twisting stresses arising from tensile forces and angular-shear loads.

Analyzing the moment of resistance of the metallic plates welding and thermal heating, where there was a, noticeable different temperature components of the loadsthe main reasons for their occurrence and impact on the hull after the repair and after the retrofit.

The analysis of the forces of welding stresses, took into account their influence on the housing structure at the time of welding production (from slow and uneven cooling after the welding process), from the appearance in the liquid welding environment of the metal multilayer multidirectional forces due to which there are corrugated formations in the near-weld zone of the welded structure, exposing the metal to plastic deformation and shrinkage. The improved technique of the welding process considers in detail the arising longitudinal and transverse angular deformations in the vertical plates of the second Board set, the double bottom flooring, where the vertical inclined sheets of bulkheads are joined not to the sub-deck set but to the deck flooring, horizontal sheets, to the longitudinal and transverse bulkhead.

Developed by the authors of a new method for welding new metal plates to the line, prevents the formation of the above defects and for its use, prepared a number of guidelines, which painted the entire process of phased production from marking, cutting to manufacturing structural parts, without allowances for additional processing. The prepared corresponding methodical instructions and the developed technical drawings, allowed to make cutting of metal sheets in strictly certain sequence on "basis" and on "duck" on the basis of which it is possible to draw the following conclusion:

- first, this is one of the main points to reduce stress in the hull structure of the tanker, reduced to a minimum deformation formation and shrinkage; nullified cracks and fistulas of welds, prevented defects of a discontinuous nature;
- the second point is a decrease in the number of welding joints in the installed hull structures and a decrease in the voltage at the joints of the vertical, horizontal and inclined sheets of the second side, the bottom and the set system;
- the third point allows you to reduce stress and strain in the hull structures include the welding process itself which must take place in compliance with temperature conditions (special attention is paid to the underwater part of the hull structure, if the re-equipment of the vessel takes place when the vessel is afloat);
- the fourth point - is the Assembly sequence of components and parts of the hull structure prepared for the installation of the double bottom and the second side, where we recommend to reduce unwanted

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

rigid joints of parts and components in the area of a solid weld, in the flooring of the double bottom and the longitudinal bulkhead of the second side.

5. SUMMARY

Observing and applying the authors developed an improved method of construction of the double bottom and the second side with the use of rational technology of the welding process: welding of new sheets to the building, allowed to obtain high-quality welds that do not have shrinkage and deformation, reduced the performance of stretching and compressing formations, increased rigidity of the hull structure, doubled the factor of safety, improved seaworthiness: increased unsinkability and stability of the tanker. This technology was used when major repairs and alterations on vessels of the project 1598R, t/x "Şamaxı", 1598 t/x "Astara", 1560 t/x "General HaziAslanov", 1677, t/x "IsrafilMammadov", 1677, t/x
"General Asadov", 1677, t/x" "Samad Vurgun", and other AOZT Caspian Sea Shipping company, where he conducted research for over 6 years and the results received positive reviews thus, in operation and during the subsequent repairs where established structures are minimized threat of defect formation

REFERENCES

[1] BashirovR.C., A.H.Rzayeva. Repair technology and rest oration of strength characteristics of the vessel hull during the construction of the secondside. International Scientific and Technical Conference on «Measurement and quality: problems, perspectives». Azerbaijan Technical University. Baku. - 2018. – 8p
[2] Bashirov R.C., A.H.Rzayeva. Repair technology of the hull structure. Textbook.Baku. ATU. - 2014. - 352 p.
[3] Bashirov R.C., A.H.Rzayeva. "Technology of welding of new sheets of the outer skin to the line". Collection of proceedings. Baku.. Azerbaijan State Maritime Academy. № 1. - 2013. - 3p.
[4] A.H.Rzayeva. "Technology of protection of the divided edges of sheets from corrosion destruction on the microscopic basis". Technical guidance № 112 from 12.11.2002. Baku. Shipyard named after Vano - Stroy. The Azerbaijan State Caspian Sea Steamship line.- 2002. - 12p.

CITE AN ARTICLE

Bashirov, R. C., & Rzayeva, A. H. (2019). INFLUENCE OF RESIDUAL DEFORMATION ON THE STRENGTH OF THE HULL STRUCTURE OF THE TANKER AFTER CONVERSION. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 8*(1), 181-188.