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**Naval Architecture Fundamentals For
Marine Warranty Surveyor**

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مبانی معماری کشتی برای بازرس تضمین
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With Gratitude,**

The attached items which include Naval Architecture Fundamentals for MWS has been sent as technical information.

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همچنین نسخه الکترونیکی این سند از طریق پست الکترونیکی به کلیه مشتریان و بازرسان محترم موسسه ارسال می گردد.

رضوان پناه

**مدیر واحد کنوانسیون ها و مقررات دریایی
موسسه رده بندی ایرانیان**

ترک دعوی: اگرچه در گردآوری کلیه راهنماهای فنی ارائه شده توسط موسسه رده بندی ایرانیان، تا حد ممکن تلاش در دقت و صحت محتوا صورت گرفته است، این موسسه متحمل مسئولیتی در قبال هرگونه اشتباهات، خسارت های احتمالی و جرانی که ممکن است در ارتباط با بکار گیری مفاهیم و مطالب ارائه شده رخ دهد، نمیباشد.

Naval Architecture Fundamentals For Marine Warranty Surveyors:

Traditionally naval architecture was regarded more as a craft than a science with a hull form derived from half block models and much store being held in the saying “if it looks right, it is right”. However, as ships and other floating structures developed both in size and complexity the craft developed into a science and the naval architect of the twenty first century is very much a multi-disciplined professional.

A marine surveyor has a responsibility to inspect and comment on the structure, machinery and systems of vessels both existing and under construction; making recommendations, if necessary, for the rectification of defects. The surveyor can on occasions be requested to advise on modifications to craft or their suitability for a particular duty and it is for this reason, among others, that a marine surveyor needs a basic understanding of the principles of naval architecture.

The aim of this module is to provide the student with a grounding in the fundamentals of marine craft and floating structure design, in particular the basic scientific principles and mathematics so that a realistic assessment of a vessel’s suitability for purpose can be derived.

Ship Construction

Terminology

Accommodation Space	Means any space, enclosed on all six sides by solid divisions provided for the use of persons onboard.
Administration Aft Perpendicular (AP)	Means the government of the state whose flag the vessel is entitled to fly. Is the perpendicular at the intersection of the summer load waterline with the aft side of the rudder post or to the center of the rudder stock if there is no post?
Amidships	Is the mid-length of the Rule Waterline or the Length Between perpendiculars?
Angle of Heel	Means an angle of heel where G is transversely offset from the vessel’s centerline and transverse GM is positive. The vessel is not upright but will naturally return to the upright condition.
Angle of Loll	Means an angle of heel where G is on the vessel’s centerline and transverse GM is zero. The vessel is not upright but it is stable at this angle and will not naturally return to the upright condition.
Block Coefficient (Cb)	This is the ratio of the fullness of the form of a vessel as measured by the volume of the actual displacement up to a given waterline compared to the volume of a circumscribing rectangular block with the same length, breadth and draught.

$$C_b = \frac{\text{moulded displacement (M3) at draught } T}{LR \times B \times T}$$

Bow Height	Means the vertical distance measured at the FP from the waterline to the uppermost deck exposed to the weather.
Breadth (B)	Is the greatest moulded breadth, in meters, or, for vessels of composite construction, the extreme breadth excluding rubbing strakes or other projections. For multi-hull craft it is the sum of the breadths of individual hulls.
Bulkhead Deck	Means the uppermost weather-tight deck to which transverse watertight bulkheads extend.
Buoyancy	Is the upward force acting on a floating, or submerged, body due to the water pressure on its outer surfaces. It is equal to the weight of water displaced if the body is in equilibrium.
Cargo	Means all items which are transported by the vessel except for fuel for the vessel, ballast (either solid or liquid), consumables to be used on board, permanent outfit and equipment of the vessel, stores and spare gear for the vessel, crew and/or passengers their personal belongings and activity related equipment.
Catamaran	Means a vessel with twin hulls linked by a bridging structure.
Category 'C' Waters	Means waters designated category C waters in the UK Merchant Shipping (Categorization of Waters) Regulations 1992, SI 1992, No. 2356 and the UK Merchant Shipping Notice MSN 1776(M).
Category 'D' Waters	Means waters designated category D waters in the UK Merchant Shipping (Categorization of Waters) Regulations 1992, SI 1992, No. 2356 and the UK Merchant Shipping Notice MSN 1776(M).
Centre of Buoyancy (CB)	Means the center of gravity of the underwater volume of a vessel. This may be defined as longitudinal center of buoyancy (LCB) or vertical center of buoyancy (VCB). If the vessel is asymmetric, possibly due to heeling or for other reasons, then the athwartships buoyancy will not lie on the geometric centerline but will still have equal amounts of displacement to either side.
Centre of Floatation (CF)	Means the centroid of any given water plane at which the vessel maybe floating.
Centre of Gravity (CG)	Means the center of gravity of the complete vessel and this may be defined as longitudinal center of gravity (LCG) or vertical center of gravity (VCG). In many circumstances of loading the Centre of Gravity (CG) will not be on the centerline.



Certifying Authority	Means bodies authorized by the UK Maritime and Coastguard Agency (MCA) to examine vessels, issue declarations of examination and issue certificates in connection with the UK Small Vessel and Pilot Boat (SCV) Code, often referred to as the Workboat Code.
Classification Society	Means a body concerned with the construction and classification of marine floating vessels and structures ensuring that they meet all international and national standards. Any new vessel built to class will subsequently be periodically checked by that society to ensure the standards are maintained through the vessel's working life.
Coefficients of Fineness	These relate to the underwater form of the hull and give an indication of the hull shape. They are the ratios of certain areas and volumes to their circumscribing rectangles or prisms.
Compartment	Means all living and working spaces within the watertight or fire resisting boundaries on any one level which have inter-communicating access.
Crew	Means a person employed or engaged in any capacity on board a vessel on the business of the vessel.
Critical Downflooding	Is deemed to occur when openings having an aggregate area, in square meters, greater than: $\frac{\text{Vessel's displacement in tonnes}}{1500}$
Cross Curve of Stability	are immersed. Moreover, it is the angle at which the lower edge of the actual opening resulting in critical flooding becomes immersed. Also known as KN curves, comprise a series of curves showing how a vessel's transverse stability varies, with displacement, for a range of heel angles.
Curve of Statical Stability	See GZ curves.
Deadweight (DWT)	Means the weight the vessel can carry.
Decked Vessel	Means a vessel which has a continuous watertight weather deck extending from stem to stern and has positive freeboard in any loading condition.
Depth (D)	Is measured, in meters, at the middle of Rule Length, or Length Between Perpendiculars, from the top of keel to the underside of the deck plating.
Design Waterline	Means the waterline corresponding to the maximum operational weight of the vessel with no machinery active.
Directional Stability	See dynamic stability below.

Design Category Means a description of the wind and sea conditions for which a vessel is considered suitable under the EU Recreational Craft Directive 94/25/EC of 16th June 1994, and used for the application of relevant ISO and CEN standards. Refer to the following table:

Design Category	Wind Force (Beaufort Scale)	Significant Wave Height (H 1/3, Meters)
A - 'Ocean'	Exceeding 8	Exceeding 4
B - 'Offshore'	Up to, and including, 8	Up to, and including, 4
C - 'Inshore'	Up to, and including, 6	Up to, and including, 2
D - 'Sheltered Waters'	Up to, and including, 4	Up to, and including, 0, 50

Displacement Means the lightship plus deadweight at any given loading condition. It is the absolute 'all-up' weight of the vessel.

Draught (T) Is the summer draught, in meters, measured from the underside of keel.

Dynamic Stability Means the measure of a vessel's stability in course keeping, otherwise known as directional stability.

Floodable Length Means the length of the hull, at any point, that can flood without immersing the margin line, assuming the vessel has no list.

Forward Perpendicular (FP) Is the perpendicular at the intersection of the summer load waterline with the fore side of the stem.

Freeboard Means the distance measured vertically downwards from the lowest point of the upper edge of the weather deck to the waterline in still water.

Freeboard Deck Means the uppermost complete deck exposed to the weather and sea, which has permanent means of closing all openings in the weather part thereof and below which all openings in the sides of the vessel are fitted with permanent means of watertight closing. It is the deck from which the freeboard is measured.

Free Surface Effect Means the loss of stability caused by liquids in partially filled tanks.

Gross Tonnage	Is a unit-less index related to a vessel's overall internal volume which was defined by The International Convention on Tonnage Measurement of Ships, 1969, adopted by IMO in 1969 and came into force in 1982.
GZ	Is the distance from the center of gravity to a line drawn vertically through the Centre of Buoyancy. It is a measure of the vessel's ability to resist heeling moments.
GZ Curves	Means a plot showing how the righting lever varies as the vessel heels about a fore and aft axis.
High Speed Craft (HSC)	Means a craft capable of a maximum speed in meters/sec., equal to or exceeding: - $3.7 \nabla^{0.1667}$ Where ∇ is the volume of displacement (M3) corresponding to the design waterline.
Hogging	Is a term used to describe a hull that is bent longitudinally concave downwards by the forces acting on it. Hogging is the opposite of sagging.
Hydrostatic Curves	Are a set of curves, for a range of draughts, indicating displacement, TPC, MCT, positions of the CB, CF, metacenter, etc.
Inclining Experiment	Means a test carried out on a vessel to confirm the position of the center of gravity.
Inflatable Boat	Means a vessel which attains its form through inflatable tubes only, which are not attached to a solid hull.
International Maritime Organization (IMO)	Is the United Nations specialist agency with responsibility for the safety and security of shipping and the prevention of marine pollution by shipping?
International Standards Organization (ISO)	Is the world's largest developer and publisher of international standards? It is a non-governmental organization with many of its member institutions being part of the governmental structure of that country while other members have their roots in the private sector. Therefore, ISO enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society.
Length Extreme (LE)	Is the extreme length of the vessel over all appendages, including bow sprits, davits, fendering, etc.
Length between Perpendiculars (LBP)	Is the distance, in meters, on the summer load waterline from the fore side of the stem to the aft side of the rudder post, or to the center of the rudder stock if there is no post.

Length Overall (LOA)	Is the distance, in meters, measured parallel to the static load waterline from the fore side of the stem to the aft side of the stern or transom, excluding rubbing strakes and other projections.
Length (Rule) (LR)	Is the distance, in meters, on the summer load waterline from the fore side of the stem to the aft side of the rudder post, or to the center line of the rudder stock if there is no post. LR is not to be less than 96% and need not be greater than 97%, of the extreme length on the load waterline. This definition is only used by classification societies.
Length Waterline (LWL)	Is the distance, in meters, measured on the static load waterline from the fore side of the stem to the aft side of the stern or transom.
Lightship	Means the displacement of the empty vessel, no fuel, water, cargo, crew or effects.
Load Line Length (LL)	Is to be taken as 96% of the total length on a waterline at 85% of the least moulded depth measured from the top of the keel, or as the length from the fore side of the stem to the axis of the rudder stock on that waterline, whichever is the greater. In a vessel with a raked keel the waterline on which this length is measured is to be parallel to the design waterline.
Longitudinal Centre of Buoyancy (LCB)	Means the fore and aft location of the center of buoyancy.
Longitudinal Centre of Floatation (LCF)	Means the fore and aft location of the center of floatation.
Longitudinal Centre of Gravity (LCG)	Means the fore and aft location of the center of gravity.
Margin Line	Means a line at least 76 mm below the upper surface of the bulkhead deck; it assists in defining the amount of flooding a vessel can withstand at any point along its length.
Maritime and Coastguard Agency (MCA)	Means the UK authority which as an executive agency of the UK Department of Transport has responsibility for the UK Merchant Shipping Regulations and their enforcement.
Master	Includes any person, other than a pilot, having command or charge of a ship.
MED	Means the EU Marine Equipment Directive 96/98/EC and 'MED approved' means approved in accordance with the requirements of that Directive.
Merchant Guidance Note (MGN)	Means a Notice described as such and issued by the UK MCA.

Merchant Shipping Notice(MSN)	Means a Notice described as such and issued by the UK MCA.
Metacenter (M)	Is the intersection of successive vertical lines through the center of buoyancy (CB) as the vessel is heeled progressively? For small angles of heel the metacenter is assumed to be on the centerline.
Metacentric Diagram	Means a diagram plotting how the metacenter and center of buoyancy (CB) change with draught.
Metacentric Height (GM)	Means the vertical distance between the center of gravity (VCG) and the metacenter (M).
Mile	Means a nautical mile of 1852 meters.
Moment to Change Trim 1 Centimeter (MTc)	Means the moment required to change the trim, between perpendiculars, or any defined points on the vessel by 1 centimeter.
Mono Hull Vessel	Means a vessel whose single hull may be of displacement form, or of a semiplaning or planing hull form subject to some support from hydrodynamic lift.
Motor Vessel	Means a power driven vessel that is not a sailing vessel.
Multihull Vessel	Means any vessel which in any normally achievable operating trim or heel angle, has a rigid hull structure which penetrates the surface of the water over more than one separate or discrete area.
Net Tonnage	Is a unit-less index related to a vessel's overall internal volume which was defined by The International Convention on Tonnage Measurement of Ships, 1969, adopted by IMO in 1969 and came into force in 1982. Net tonnage is often used to calculate port duties and should not be taken as less than 30% of the vessel's gross tonnage.
Passenger	Means any person carried on a vessel except: - a) a person employed or engaged in any capacity on the business of the vessel; b) a person on board the vessel either in pursuance of the obligation laid upon the master to carry shipwrecked, distressed or other persons, or by reason of any circumstance that neither the master nor the owner nor the charterer (if any) could have prevented or forestalled; c) a child under the age of one year.
Passenger Vessel	Means a vessel which carries more than twelve passengers.

Permeability	Means the measure of the free volume of a compartment; it defines the maximum amount of water that can flood that space as a result of damage or bilging. It will be less than unity to take account of structure, machinery, equipment or stores in the compartment.
Perpendiculars	Refer to aft (AP) and forward (FP) perpendiculars.
Port (P)	Means the left hand side of the vessel when looking forward.
Range of Stability	Refers to the range of heel angle over which a vessel is stable; that is when GZ is positive.
Reserve of Buoyancy	Means the buoyancy that can be provided by the watertight volume of the vessel above the design waterline.
Righting Lever	Means a lever that will bring a stable vessel back to the upright after being displaced by temporary external forces.
Righting Moment	Means a moment that will bring a stable vessel back to the upright after being displaced by temporary external forces.
Rigid Inflatable Boat (RIB)	Means a vessel with inflatable tubes, attached to a solid hull in such a manner that as normally inflated they form bulwarks to the vessel. The tubes are inflated during the vessel's normal operations.
Safety of Life at Sea (SOLAS)	Is a statutory regulation of IMO dealing with the safety of life at sea.
Sagging	Is a term used to describe a hull that is bent longitudinally, concave upwards, by the forces acting on it. Sagging is the opposite of hogging.
Sailing Vessel	Means a vessel that is designed to operate under wind power alone and for which any engine provided is an auxiliary means of propulsion and/or which possesses a no-dimensional ratio of (sail area) divided by (volume of displacement) ^{2/3} of more than 7.
Scantlings	Means the dimensions of the structural elements making up a vessel's structure.
Sheer	Means the rise of the deck from amidships towards the bow and stern.
Ship	Includes every description of a vessel used in navigation.

Simpson's Rules	Are formulae used for calculating areas, moments, volumes and inertias, without the need for calculus.
Stability	The term stability refers to the tendency of a floating vessel to return to its original state after it has suffered a small disturbance, after buffeting by wind or waves for example.
Stability Information Booklet (SIB)	The booklet explains the hydro-graphic dimensions of a vessel.
Starboard (S)	Means the right hand side of the vessel when looking forward.
Tonnes per Centimetre Immersion (TPC)	Means the weight in Tonnes necessary to immerse the vessel by one centimeter. This is calculated for each working water plane and is shown within the hydrostatic data in a vessel's stability information book. $TPC = \frac{A_w \times \rho}{100}$ <p>Where: - TPC = Tonnes per centimeter immersion, Tonnes, A_w = Area of the water plane, (M²) ρ = Density of the water in which the vessel is floating. (T/M³)</p>
Trim (Apparent)	Means the difference between the draughts observed at the forward and aft marks.
Trim (True)	Means the difference between the draughts at the forward (FP) and aft (AP) perpendiculars.
Vertical Centre of Buoyancy (VCB)	Means the vertical location of the center of buoyancy.
Vertical Centre of Floatation (VCF)	Means the vertical location of the center of floatation.
Vertical Centre of Gravity (VCG)	Means the vertical location of the center of gravity.
Void Space	Is any space, having no practical function on board the vessel, not capable of readily collecting water under normal operating conditions.
Watertight	Means capable of preventing the passage of water in either direction.
Weather Deck	Means the main deck that is exposed to the weather and sea.
Weathertight	Means capable of preventing the entry of a significant quantity of water into the vessel when subjected to a hose test.



Workboat	Means a small vessel, under 24 meters in length, in commercial use for purposes other than for sport or pleasure or as a dedicated pilot boat.
Yacht	Means a recreational craft used for sport or pleasure which may be propelled mechanically, by sail or a combination of both.