MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mechanical Engineering

2.701 PRINCIPLES OF NAVAL ARCHITECTURE
Fall 2014

PROJECT #5: HULL SUBDIVISION and DAMAGE STABILITY

Date issued: Oct 20, 2014
Date due: Oct 31, 2014

Reference: Gillmer and Johnson Chapter 10

1. Introduction/background:

As discussed in class, there are many hazards your ship will encounter over its service life. Your ship design must take these hazards into account. You must design your ship to handle various conditions that account for the extent of the damage as well as the location of the damage. Then, you must ascertain an acceptable ship condition after the damage. Things you must consider include sinkage, drafts, heel, trim, metacentric height (GM), righting arm (GZ), range of stability (ROS), righting energy, etc. One method of evaluating a ship's ability to sustain damage and remain afloat and stable is to develop a Floodable Length Curve and subsequently subdivide the hull, using watertight transverse bulkheads, so that it meets damage stability requirements.

Various computational tools can be used to compute the Floodable Length Curve and perform a damage stability analysis. For this assignment we will use the Advanced Surface Ship and Submarine Evaluation Tool (ASSET). Computers, with ASSET software loaded, are available in the 2N Ship Design Lab (Room 5-306).

2. Assignment:

Using your baseline ship from Project #1, locate transverse bulkheads such that your ship meets the minimum damage stability criteria specified in DDS-079-1.

3. Process:

Run Synthesis again on your ship from Project #1 (you should do this any time you reopen a previously saved model).

In the Editor:

- Verify that Hull Subdivision Indicator = GIVEN (why? Check the Help files)
- Set the Floodable Length Permeability = .9. Delete all other instances

Run the Hydrostatics Analysis Module and print out the Floodable Length graphic. Stretch it as large as you can on the page, because you are going to be doing some pencil work on it.

Using the longitudinal locations of your watertight transverse bulkheads from the editor, determine the worst-case damage condition at each longitudinal location on the ship. To do this, you will need to add 15% LBP to each transverse bulkhead location and determine how many other transverse bulkheads would be damaged in that situation. Using the Floodable Length graphic, draw the corresponding *flooded* length triangles from the bracketing *intact* transverse bulkheads to see if the extent of damage exceeds the *floodable* length at that location. For purposes of this project we are using a 90% permeability curve for the entire length of the ship. This is a simplification; each compartment has a specified permeability based upon its use (engine room, berthing, etc).

If your *flooded* length exceeds your *floodable* length anywhere on the ship, you will need to adjust your transverse bulkhead locations in the editor, or possibly add transverse bulkheads. If your flooded length is too conservative (i.e., well below the floodable length curve), then your transverse bulkheads are too close together or you have too many—you are adding unnecessary weight and restricting access. You should increase the distance between them or remove a transverse bulkhead.

<u>In the Editor:</u>

- The location of transverse bulkheads is listed in the array Transverse Bulkhead X Location. Select Transverse Bulkhead 000001 and then click on the button “View Data in Table Format” to see the entire array.
- Run the Hull Subdivision Module and Synthesis to incorporate your changes.

After each adjustment, run Synthesis and then the Hydrostatic Analysis Module again, and recheck your flooded length triangles by marking up the floodable length graphic. Go through this process at least twice. Get your flooded length triangles as close as you can to the flooded length curve without exceeding it, but you don’t have to iterate more than twice. Your final design must not EXCEED floodable length anywhere.

4. Deliverables:

D-1: Three printed floodable length graphics, indicating where you moved/added/deleted bulkheads and showing all appropriate flooded length triangles.

D-2: A table showing the original and final locations of your bulkheads as a fraction of LBP.

D-3: Answers to the following questions:

1. Does floodable length analysis account for off-center flooding? If so, how? If not, do we account for it?
2. Weight and access are negatively affected by overly-conservative watertight subdivision. Name two other things that are negatively affected.
3. Compare the US Navy’s 15% LBP damage criterion with commercial “integer compartment” criteria (< 100ft LBP-1 comp, 100-300ft LBP-2 comp, > 300ft-3 comp). Which is more conservative, and what makes it so?
4. Using your floodable length curve as a reference, explain how increasing and decreasing permeability would affect your design.