A Gentle Introduction to MOSES

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Contents

1 Introduction

The purpose of this document is to provide a gentle introduction to the MOSES software package. It is intended as a complement to the MOSES manual, example and test files, and the web page. The approach taken here is to:

- discuss an example or a test
- ask the user to change a few entries, and
- discuss the changes in the results

All the files needed to complete the exercises are contained in the standard MOSES distribution. It is a good habit to copy these files to a working directory so that you can always revert to the original. It is up to you to decide to copy the files or work within the ultra directory. There is a word of caution to be said here.

> When you receive a MOSES update, or you decide to download a new MOSES revision, the installation wizard will write over any files in the ultra directory. **If you chose to work in the ultra directory you run the risk of losing your work.**

For each exercise I tried to have a set of topics, reference files, other commands to use, and a purpose before the discussion. The discussion covers by example the topics listed. The reference files were used to present the topics. In most cases the reference files are part of the standard MOSES distribution. The list of "other commands to use", is a list of other commands that are presented but are not discussed, nor have they been discussed in previous exercises. I mostly tried to list the commands that had used a feature not directly related to the topics. It is left to the reader to find the "other commands" in the manual.

Text Editor

You will need to view and change the text of many files. You are welcome to use any editor of your choice. Popular text editors are WordPad, VI, Crimson Editor, Medit, Ultra–edit, and Emacs. It is assumed that you know how to use the editor you choose and no attempt will be made to try to teach how to use an editor.

I do make reference to line numbers. It will be easier to follow if your text editor shows line numbers.

1.1 Installing MOSES - Windows

On a Standalone Machine

- CD-ROM Versions
  - Insert the CD. It should start the install procedure. If not, go to the CD–ROM drive (often D:) and double–click on setup.exe.
- Download Versions
  - Locate and run the downloaded file. It should be called something similar to moses_download_win32.exe.
- Both Versions
  - Press Next until you get to the "Choose Components" screen.
  - If you want to keep your old MOSES install, select "Backup old files." This will create a directory ultra_p with your old MOSES install and settings.
  - Associating Files registers MOSES's CIF and DAT extensions with Windows so you can double click on them. This is recommended for most machines, but is not necessary for installs on a file server.
  - Do not install the Sentinel Hardkey Driver unless you are using a Sentinel Hardkey and this is the only program that is using it. Otherwise, this can conflict with previously installed drivers.
  - Allow the installer to complete.
  - You should now be able to double–click on any .cif file on the machine and have MOSES run.

On a Networked Machine (instructions for IT staff and advanced users)

On the File Server

- Install the software by following the steps above.
- Change the permissions as follows:
  - \ultra −read (all files and subdirectories)
  - \ultra\data\progm −read−write
  - \ultra\data\site −read−write
- Share the \ultra directory or a parent directory of \ultra

On the users machines

- Mount the \ultra directory as a drive; we will use U: in this example.

- There should be a moses.exe under U:\ .
- Double click (run) moses.exe. This will bring up a MOSES window.
- MOSES will ask for a file name. Use the name ”cow”. (cow without the quotes)
- After a few seconds the main menu will appear at the top of the screen.
- Use the pull down CUSTOMIZE menu.
- Select Register with OS.
- Close MOSES by typing &FINI in the command prompt
- You should now be able to double–click on any .cif file on the machine and have MOSES run.

2 Basic Exercises

2.1 Getting Started Exercise

Topic:

- Introduction to basic MOSES commands.
- Demonstrate how to restart an analysis and make modifications.

Commands to use: MOSES b_run

Setup Analysis

Run ultra/hdesk/started/b_run/b_run.cif and b_run.dat

Discussion: Running MOSES

In this exercise, the student will become familiar with the file structure and run a simple analysis. At this point we are not interested in understanding every command just the concept of menus.

For a list and discussion of the commands found in most examples please see:

http://www.ultramarine.com/hdesk/runs/c_htm/common.htm

A discussion and screen shots of the process are also presented at the following link.

http://www.ultramarine.com/hdesk/started/b_run/b_run.htm

If using Windows you should double click on the file b_run.cif. The file b_run.cif should have an icon that looks like a parabolic shape inside a half rectangle. Once you double click the cif file the MOSES window should appear and the analysis commands scroll by. This should take a few minutes, at most. When the MOSES window disappears there should now be a b_run.ans and a b_run.dba directory.

The dba directory is where the database is located. All the files in this directory are for computers, i.e. not for human eyes. The files in the ans directory contain the answers (ANS is short for answers).

At the conclusion of the MOSES analysis we will normally look at the log and the out file, which can both be found in the ans directory. The log file is a log of the commands used to perform the analysis. The out file is the results of the calculations.

In some exercises you will be asked to "tidy the run". This means delete the ans and the dba directory. At other times you will be asked to "restart the run", this means you should access the existing database. You "restart the run" by double clicking on the cif file. You should not delete the ans directory unless you are asked to do so.

Discussion: The Analysis

In this analysis a vessel is set at a draft and trim the weight necessary to be at equilibrium is computed then three sets of hydrostatic calculation are reported.

Three things are done in this analysis.

> The curves of form are computed with the section beginning with the command *cform*
>
> Stability righting arm and heeling arm curves are computed with the section beginning with the command *rarm*
>
> Longitudinal strength is computed with the section beginning with the command *equi_h*

Notice that the comments in the .cif file tell us we are entering the hydrostatics menu. Once inside the hydrostatics menu we can perform hydrostatic calculations. When MOSES is working if you look at the upper blue bar you will notice that the words change from "Main Menu" to "Hydrostatic Menu" and "Disposition Menu".

Notice that after each *report* command there is an *end* command. After each calculation MOSES is in the disposition menu. When we ask MOSES to *report* we are asking MOSES to dispose of the results. Once we have finished reporting we *end* that section of the calculations.

After each of the calculations there is a plot generated with the command *plot*. The numbers after the command *plot* tell MOSES what variables to use as the ordinate and as the abscissa. We can edit this file and add the command *vlist* before or after the command *plot* to get a map of the number to variable used.

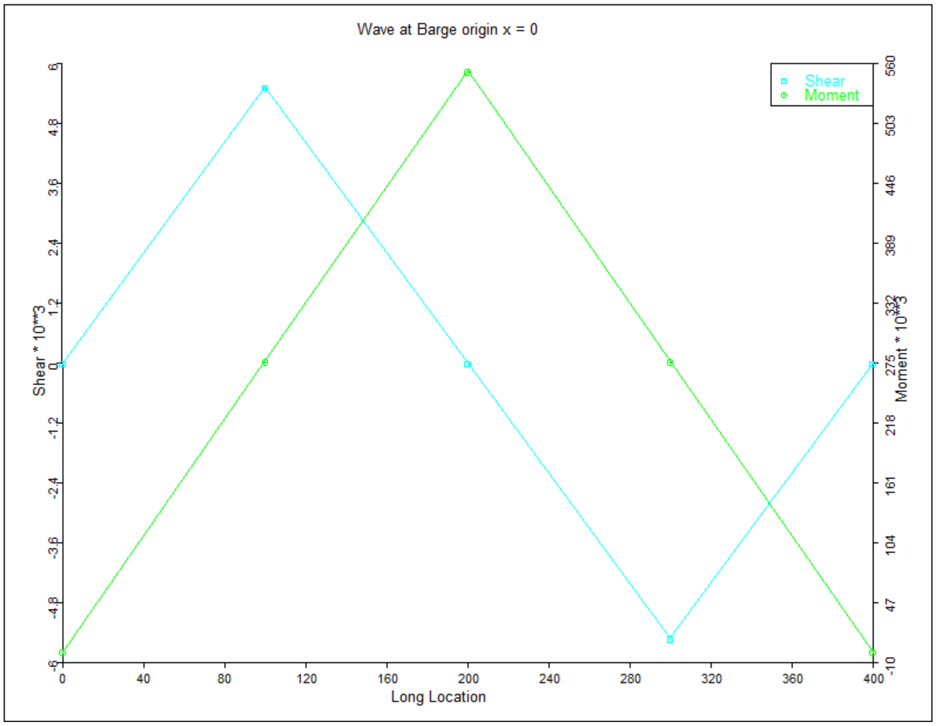


Figure 1: Hog case for basic run

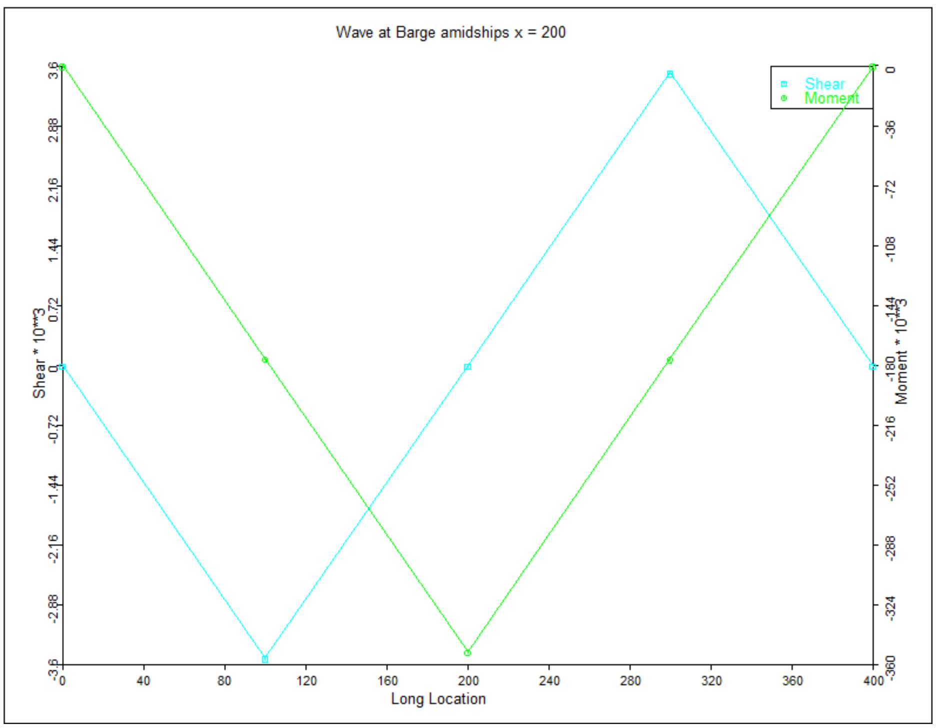


Figure 2: Sag case for basic run

Answer the following questions. The answers are found in the directory b_run.ans in the out00001.* file .

Questions:

1. What is the KML and KMT for a 12 ft draft?
2. What is the righting arm at 28 deg roll?
3. At what longitudinal location does the shear force cross the zero axis for the wave crest at location 0.0 ?
4. At what longitudinal location does the shear force cross the zero axis for the wave crest at location 200.0?

2.2 Basic Stability

Topics:

- Righting arms
- Defining weights
- Model summary reports

Reference files: bstab.cif, bstab.dat, wcomp.cif, wcomp.dat

Discussion

The files bstab.cif and bstab.dat are example files that come with MOSES. They are located in the ultra/hdesk/runs/samples/hystat directory. (This assumes you installed MOSES with the defaults. If not, the directory is below where ever you installed the ultra directory.)

There is a plethora of information on the Ultramarine web site. The discussions and exercises hopefully will also provide a good tour through the web site.

The discussion for these two files are located at:

- http://www.ultramarine.com/hdesk/runs/samples/hystat/bstab.htm
- http://www.ultramarine.com/hdesk/runs/samples/hystat/wcomp.htm

After you have read the discussion see if you can answer the following questions.

Bstab Questions

1. For the Draft 7 ft with a KG = 5.5 ft what is the GML for CBRG180?
2. What is the Y radii of gyration (K–Y) CBRG180?
3. Why are there only ten rows in the RIGHTING ARM RESULTS report?

Change the top of the file to read:

&dimen –DIMEN FEET KIPS
&device –oecho no

If you look up the command *&device* in the users manual you will see that this option controls part of the output.

4 What is different between this output and the original output?

Wcomp Questions

1. What is the maximum amount of ballast for compartment 4C?
2. What compartments are filled to 100%?
3. What is the area ratio at 12.5 degrees?

Exercise

Add the following lines to wcomp.dat:

```
&describe body cbrg180
&describe part cargo
pgen cargo –cs_curr 1 1 1 –cs_win 1 1 1
  plane 50 70 100 130 –rect 14 40 20
end
```

In the hydrostatic section of wcomp.cif alter so that it reads:

```
HSTATICS
$
$******************************************   stability trans.
$
  RARM 2.5 10 –WIND 100
    REPORT
  END
  tank_capacity 5p 1
    report
  end
end
```

Questions

1. What is the free surface moment for compartment 5P?
2. What is the area ratio at 12.5 degrees?

2.3 Free Surface Correction

Topics:

- Tank ballast reporting
- Plotting options
- String functions

Reference files:

/ultra/hdesk/runs/samples/hystat/fs_mom.cif, fs_mom.dat

Discussion

Lets start by reviewing the dat file. Here we use the one of the barges from the barge library, SMIT5. There have been three weights added to the barge. The location of the weights is set with the points *wg1 *wg2 *wg3. Notice that we specified which units we are using with the *&dimen* statement. This is always a good idea to specify the units at the top of the file.

Lets look at the dimension statements in the cif and the dat file. This analysis will start using meters and m–tons. The command in the dat file tells MOSES to:

- Save the current dimensions (-save) then,
- Accept all future input as feet and kips (-dimen feet kips).

The last command in the dat file (*&dimen -remember*) tells MOSES to return to the previous (saved) dimensions.

All this might seem elementary, but by using the *–save* and *–remember* options, many errors due to units can be avoided.

For this exercise we will discuss the cif file and the output it produces at the same time.

The cif file has many of the commands that we have seen before. The condition is set by *&instate*, then some ballast water is put in the compartments with *&compartment*. Then we make a selector named ":tow" to pick six compartments for MOSES to work with. Notice that two of the compartments we chose for MOSES to work with are also compartments that we have placed water in.

A selector name begins with the colon (:) character. Just as in any language, there are special characters in MOSES. In MOSES the : is a special character. The complete list of special characters can be found at:

http://www.ultramarine.com/hdesk/ref_man/cmd_menu.htm

Next we ask for a report of the categories with *&status cat*. If we look at the out file we see there are five categories that have been defined. There are the three weights we saw in the dat file and the barge comes with two categories on its own, FUEL and L_SHIP. (L_SHIP stands for lightship.)

Please notice that the table header reads "Category Status for Selected Parts". For our analysis there is only one body and there is only one part. So we do not have to worry about getting confused. In later exercises we will be working with several parts so we need to read the table headers carefully to fully understand its contents.

If you scan the cif file you will notice that there are titles added (first, second, third) in lines 17, 22 and 28. In the reports with the title "first" the barge is not in equilibrium. In the reports with the title "second" ballast water has been added with the *&cmp_bal* command and the barge is now in equilibrium. The commands *&status b_w –hard* and *&status compart –hard* produce the tables titled "Buoyancy and Weight for SMIT5" and "Compartment Properties" in the output file. For those with the page title "second" we have not specified a fill type, so the default of "CORRECT" is used. For those with the page title "third" we have specified the fill type for compartments 1PSS, 3PSC, 3SBC, 5PSS and 5SBS. Specifying the fill type was done with the command *&compart –app_none :tow*. If we read the manual we find that *–APP_NONE* uses the correct CG when it is filled and uses zero for the derivatives (no free surface correction).

Now if we return to the output we see that

GM is not reported in "first",

GM is reported as 12.60 meters in "second",

GM is reported as 12.80 meters in "third",

The three pages from the output are shown below.

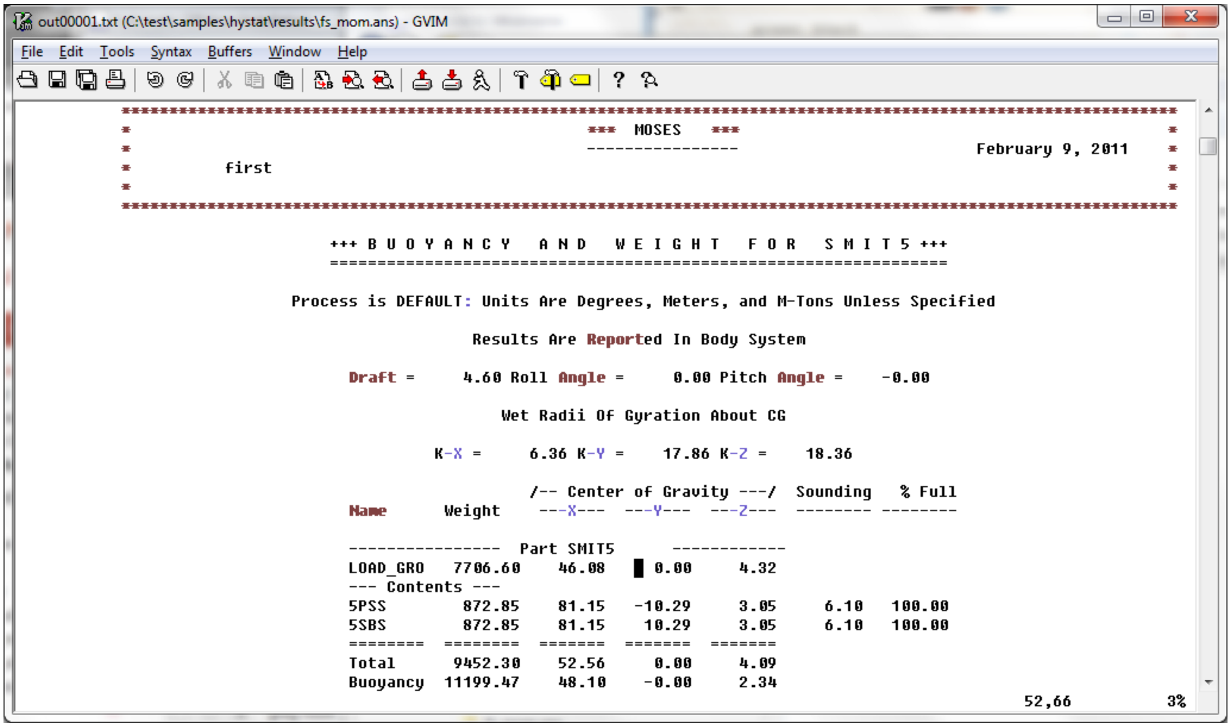


Figure 3: Results of &status b_w when not in equilibrium

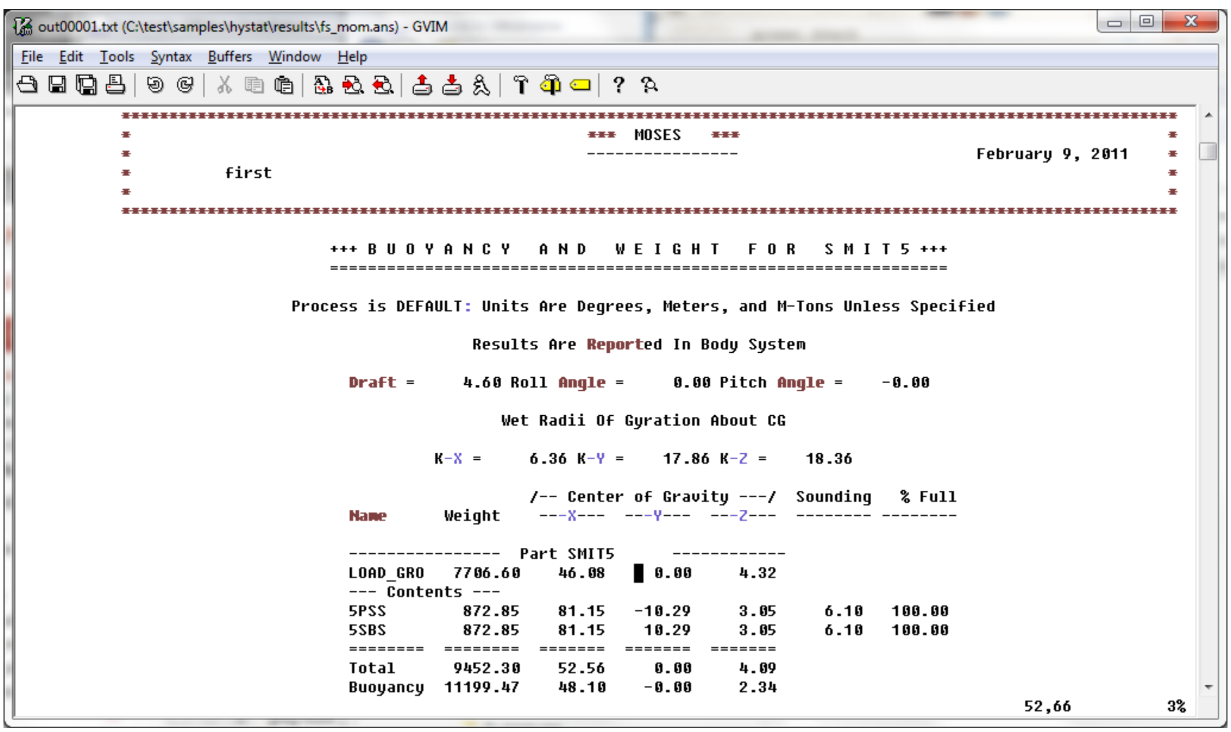
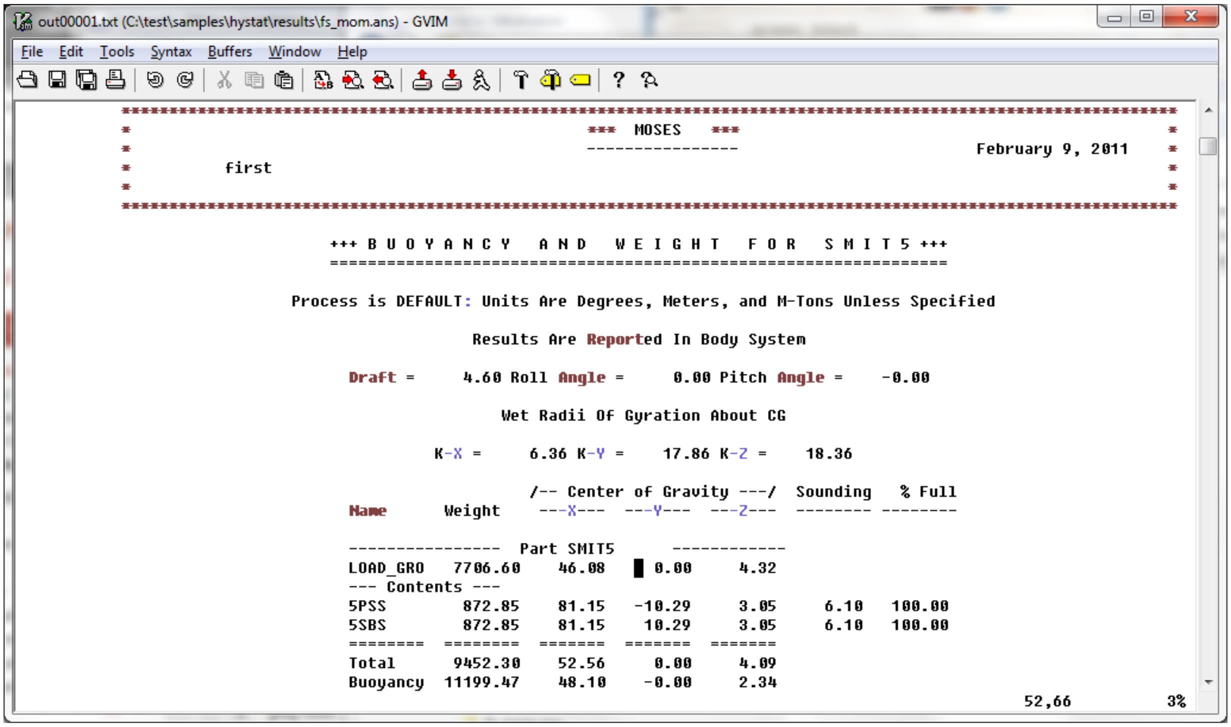


Figure 4: Results of &status b_w with type "correct"



```
out00001.txt (C:\test\samples\hystat\results\fs_mom.ans) - GVIM
File  Edit  Tools  Syntax  Buffers  Window  Help
******************************************************************************************
*                                    ***  MOSES  ***                                     *
*                                    ---------------                 February 9, 2011    *
*         first                                                                          *
*                                                                                        *
******************************************************************************************

                     +++ B U O Y A N C Y   A N D   W E I G H T   F O R   S M I T 5 +++
                     =================================================================

              Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

                                 Results Are Reported In Body System

                   Draft =     4.60 Roll Angle =     0.00 Pitch Angle =    -0.00

                                    Wet Radii Of Gyration About CG

                          K-X =     6.36 K-Y =    17.86 K-Z =    18.36

                                  /-- Center of Gravity ---/  Sounding   % Full
                   Name      Weight   ---X---  ---Y---  ---Z---  -------- --------

                   ----------------  Part SMIT5      ------------
                   LOAD_GRO   7706.60    46.08     0.00     4.32
                   --- Contents ---
                   5PSS        872.85    81.15   -10.29     3.05     6.10   100.00
                   5SBS        872.85    81.15    10.29     3.05     6.10   100.00
                   ========  ========  =======  =======  =======
                   Total      9452.30    52.56     0.00     4.09
                   Buoyancy  11199.47    48.10    -0.00     2.34
                                                                           52,66          3%
```

Figure 5: Results of &status b_w with type "app_none"

Lets concentrate on the GM change between the second to the third case. Now if you remember from your naval architecture class free surface in the compartments reduces the metacentric height. What is being shown here is that the third set in which we specified the compartments to with a fill type of *APP_NONE* do not have a free surface moment correction.

Lets look briefly at the commands towards the end of the file. We have used the *cform* command before to generate the curves of form. The curves of form include the displacement and the distance from the keel to the metacenter (KM). Note that the curves of form are based strictly on the hull geometry.

Also toward the end of the command file we have *tank_capacity* This command generates the tables titled "Tank Capacities for XXXX" where the XXXX is the compartment name. The columns we are interested here are the Free Surf. Moment – Trans. and Long. If we review the Buoyancy and Weight report we see that the 3XXX and the 5XXX compartments are filled to 85%. The Tank Capacities report the free surface moment to be 562 for the 3XXX and 561 for the 5XXX. We will work with 562 for the calculations here.

Calculating the free surface is simple enough. We should be able to verify the change of 0.2 meters. We know that Free Surface Correction is the Free Surface Moment divided by Displacement.

$$fs\_cor = fs\_mom/displacement \qquad (2.3 \quad 1)$$

So far we have the free surface moment. For the displacement we look at the buoyancy and weight report to get the draft of 4.60 meters or we can look at the curves of form for the displacement 11199.47 m–tons. This would be 10,929 m^3. If we do the math we find that each compartment reduces the metacentric height by 0.05 meters. Since we have four compartments the metacentric height is reduced by 0.2 meters. And we see this is true. The difference between the GM with (12.60 m) and without (12.80 m) free surface correction is 0.2 meters.

What else does this influence? The free surface correction also influences the righting arms. Here the righting arms are reported and plotted. The reports titled "back to correct" include the free surface correction. As you can see the righting arm without the free surface correction has a maximum of 2.41 around 24 degrees. Whereas as the righting arm with the free surface correction has a maximum of 2.33 around 24 degrees.

Questions

In the previous exercise you turned on the wind model with the option *–cs_cur* and *–cs_win*. That was for a barge that we modeled just for the exercise. Here we are using a barge from the barge library. Go to:

http://www.ultramarine.com/hdesk/tools/vessels/vessels.htm

And read how making the following alteration to the dat file

&set v_cur = 1
&set v_win = 1

will turn on the wind and current part of the model.

1. What is the wind heeling area at 38 degrees?

2.4 Stability Check and KG Allow

Topics:

- Introduction to Automated Installation Tools
- Working with the stability macros
- Defining an environment
- Reporting mean wind force

Reference files: m_stab.cif, m_stab.dat, i_stab.cif, i_stab.dat, box.dat

Discussion

The discussion for i_stab.cif and i_stab.dat are located at:

http://www.ultramarine.com/hdesk/runs/samples/hystat/i_stab.htm
http://www.ultramarine.com/hdesk/ref_man/install.htm

The discussion for m_stab.cif is located at:

http://www.ultramarine.com/hdesk/runs/samples/hystat/m_stab.htm

The file i_stab uses the automatic installation tools to perform a stability analysis. The m_stab files also use a macro. The m_stab files use the stability macros. The stability macros allow for more control over the criteria.

I_STAB Discussion

The i_stab files are meant as an introduction to the Automated Installation Tools. The full description of the automated installation tools can be found at the second link listed above. If you go there you will see the files can be long and detailed. For this example we are really interested in setting up the most simple of examples for a stability analysis. For this exercise we are really just interested in understanding a few sections of these two files. Please do read the manual sections that correspond to the sections we discuss here. We will be working with the automated installation tools in several of the exercises. By reading the manual presentation in sections it will make understanding of the entire tools much easier.

Let us start with the cif file. At the beginning of the cif file after the *&device* command there are five variables (launch, transportation, loadout, upend and lift). As implied by the name of the exercise we are really just interested in stability, and we are just interested in transportation stability. So the only variable that has been set to ".true." is "transportation".

The other section of i_stab.cif we want to familiarize ourselves with is commented with the word "transportation". The section has an if statement so that the transportation calculations are only performed if the "transportation" variable is set to ".true.". As we have done here.

This three line section is what we want to pay attention to for our transportation stability analysis.

```
inst_tran    –wind 83.19 50 100 100 –draft 6 –trim 0.53 \
             –damage 1s 2s 3s 4s 5s                     \
             –no_seakeep
```

The analysis done here uses some defaults. The barge is set in a condition where the draft is 6 ft and the trim is 0.53 deg. A phantom weight is added so that the system (barge plus cargo) are at an equilibrium, then the stability analysis is performed. Here the only check is that the area ratio be greater than 1.4 and that the range is greater than 36 degrees. The stability analysis is done six times: one for the intact and once for every damaged compartment listed after the option "–damage". The numbers after wind specify the wind speed in knots for the different analyses (intact stability, damage stability, vortex shedding, and structural analysis). For our exercise we will use 83.19 knots for intact stability and 50 knots for damage stability; for now that covers all our interests for the cif file.

For the dat file we are interested in two lines at the top and a section near the bottom. If you open the dat file the first two command lines at the top:

```
use_mac install
&dimen –save –dimen feet kips
```

In order to use the automated installation macros you need to have the *use_mac install* command near to the top of the dat file. And of course you need to tell MOSES what units you will be working in. This is done with the *&dimen –save –dimen feet kips* command.

Now go almost to the end of the file, lines 60 through the end. Here we tell MOSES to use one of the vessels, cbrg180, from the library. Next we set two variables "port_nod" and "stbd_nod". If you review the file box.dat you will see that the four points are at the bottom of the piece labeled "box". The point names are selected to help position the box on the barge. The point names are the two characters after the * symbol. The points that begin with the letter "p" are on the port side and points with the letter "s" are on the starboard side. The points that end with the letter "s" are at the stern while points that end with the letter "b" are at the bow. The rest of the file box.dat will not be discussed here.

The next three lines tell MOSES to place the "box" model 42 ft from the bow with the midpoint between the starboard and port points on the centerline and 6.896 feet vertically from the barge deck. Now normally the word following a "–" sign is an option. This is the exception. Here the –PORT_NOD and –STBD_NOD options are needed. These options tell MOSES to use nodes as listed. It is important that the node order be from the stern to the bow. Or if we were to model a jacket for launch, the node order to be from leading to trailing.

The last setting tells MOSES to place the box model on top of launchways. Now this will cause some assumptions to be made later, since we are not telling MOSES sufficient information to make a good model of the launchways.

For now that is all we are going to discuss of the automated installation macros. Please read the sections in the manual that pertain to the sections discussed here.

If you now review the log file. The log file in this case tells you a bit more about what is going on. It tells you that some dimensions were needed, but since they were not provided MOSES made an estimate. It tells you the weight, center of gravity, and radii of gyration of the model "box".

The section below the *inst_tran* command tells us the results of the intact stability analysis. We know from the log file that the analysis failed the range criteria. And it lets us know that the ballast needed cannot fit in the barge.

Now lets look at the out file. This first section (through page 10) is part of the standard output generated with the automated installation macros. The Model Size and Program Parameters let us know a little about the problem we are solving. The External Piece Summary tells us a bit about the barge CBRG180 piece MAIN and the piece BOX. We see that the barge does not attract wind loads, and therefore our stability may be under estimating the wind arm. The Category Summary for Selected Parts tells us the same things that the log file did about the BOX model. The Class Dimensions, Material and Redesign Properties, and Class Section Data, tells us about the parts MOSES had to estimate. In the dat file we simply told MOSES to put in a launchway. MOSES did not have sufficient information to make an appropriate model. There were messages about this in the log file, and here are the results. For this analysis we are doing stability and we do not care about the the stress. In later exercises when we are doing a structural analysis we will care more about these reports.

The next report, Restrain Summary, we do care about. Here is one way we can make sure that the box was placed where we asked it to be placed. We can see that *PB and *SB were placed 42 feet from the bow, each is equidistant from the center line (the midpoint between them is on the centerline) and they are 20.89 feet from the keel. The first two are easy to check on, but what about the 20.89 feet. If we go to:

http://www.ultramarine.com/hdesk/tools/vessels/cbarges/cbrg180.htm

we see that the depth of the barge is 14 ft (the distance from the keel to the deck). We told MOSES to put the box 6.896 feet above the keel. So we get 14+6.896 =

20.89 feet.

For the next several pages we get Righting Arm Results tables. The table headings let us know if it is intact or damaged. The damage cases includes a line which reads "Compartment Flooded are: XX" to indicate the damaged condition. Please notice that all the roll columns begin with the value 0. Also please notice that table headers include a line that reads "Initial: Roll = X.xx, Trim = X.xx deg". These initial values are the equilibrium position. The values in the Roll and Trim columns are referenced to the initial values. For the results where 1s is damaged the righting arm when the vessel is at (2–1.44=) +0.56 deg roll is 0.35 feet.

After the stability results are reports summarizing the configuration. If you recall these are the results of the *&status* command. The following associates the command with the table header.

&status configur	Current System Configuration
&status b_w	Buoyancy and Weight for CBRG180
&status force	Forces Acting on CBRG180
&status compart	Compartment Properties
&status category	Category Status for Selected Parts
&status draft	Draft Mark Readings

M_STAB Discussion - Stab_ok

Lets first review m_stab.dat.

The first command *use_mac stab* has a similar format to that which we found in i_stab.dat *use_mac install*. This command tells MOSES that we will be using the stability macros. MOSES comes with a set of tools for the more frequent analysis. Among these tools are stability, finding allowable KG, finding allowable deck load, and transportation analysis. Here we will be working with the stability macros.

The command *use_ves* enables us to use a vessel from the vessel library.

Then we define two nodes *bcg and *ccg. In MOSES part of the geometry is defined with nodes, and node names begin with the * symbol. Please see the following link for a more complete discussion on defining nodes.

http://www.ultramarine.com/hdesk/ref_man/geometry.htm#*

Next we define areas with their centers at *bcg and *ccg. Notice that the names given to the nodes are your choice. Here bcg stands for "barge center" and ccg stands for "cargo center". Point names can be up to 8 characters, but the "*" counts as 1, so you choose the 7 characters after the "*".

Please notice that we defined the area perpendicular to the x direction and the area perpendicular to the y direction in different lines. The area perpendicular to the y direction is 180*7 ft^2 for the barge and 80*75 ft^2 for the cargo. The area perpendicular to to the x direction is 50*7 ft^2 for the barge and 50*75 ft^2 for the cargo. In the following exercises you will be asked to verify the above two statements.

Towards the end of the file, four more points are defined as non–weathertight points. That concludes the dat file.

The commands in the cif file should look familiar. Here we see two instances of the *&status* command. In the first "B_W" is reporting the buoyancy and the weight, and in the second "nwt_down" the location of the non–weathertight points is being reported.

We already have learned that the command *&instate* sets the current condition. The command *&weight* determines the weight so that the current condition is at equilibrium, and the *HSTATIC* puts us in the Hydrostatics Menu

The two new commands are *stab_ok* and *kg_allow*. The command *stab_ok* asks MOSES "Is the stability OK?". The command *kg_allow* asks MOSES "What is the allowable KG?".

The stab_ok macro is used twice. The first time is for intact stability and the second time is for damage stability. Note that in the second time, we are damaging compartment 5p (see option –damage 5p). In both cases we are checking that the intact area ratio be larger than 1.4 and that GM is positive.

Output Discussion

The log file has the familiar buoyancy and weight report. The height of the non–weathertight downflooding points is 13 ft. This stands to reason since they were defined at 20 ft above the keel and the current draft was 7 ft.

Notice that for the stability results of the intact case two criteria are reported and for the damage case only one criteria is reported. This is because for the intact case two criteria were defined and for the damage only one was defined. Please keep in mind when using this macro that MOSES will only check what it is asked. MOSES does not have an automatic list of criteria to check.

Exercise A

Use the same wcomp files as in the Basic Stability exercise.

The following are excerpts from the CFR. Each unit must be designed:

1	to have at least 1 inches of positive metacentric height.
2	Area (a) >= K * (Area (B)) K = 1.4 Area (A)under the righting moment curve between 0 and the second intercept angle Area (B) is the area under the wind heeling moment curve to the second intercept.
3	Area under the righting arm curve up to the angle of maximum righting arm equal to or greater than 15 foot-degrees.

The following is how they map to the options presented in the *stab_ok*.

1	The GM must be greater then IGM (or DGM)	IGM >= 0.083
2	The area under the righting moment curve will attain a ratio with the area under the wind heeling moment curve of at least IRATIO (or DRATIO), with both measured at the lesser of the downflooding angle or second intercept.	IRATIO >= 1.4
3	The area under the righting moment curve up to the angle where the righting arm is maximum is at least IARE@MARM (or DARE@MARM) ft-degree or m-degrees.	IARE@MARM >= 15

Questions Check the three criteria above for both the intact and damage stability. Check these for a draft of 7 ft.

1. Check intact stability for 100 knot wind. pass/fail ?
2. Check damage stability for 50 knot wind, damage compartment 5P. pass/fail ?

M_STAB Discussion - KG_ALLOW

The documentation of the Allowable KG command is at the same location as STAB_OK.

The last part of m_stab.cif file finds the allowable KG. Here we have to be careful about what center is being referred to. If you review the log file you will see that MOSES iterated many times and reports the allowable KG to be 20.93. If you review the out file, you see that the subtitle reads VCG = 20.93 Ft and the table header reads KG = 15.61. There seems to be some confusion here. What is being referenced with VCG and what is being referenced with KG? Add the following before and after the *kg_allow* command:

&status categ -both

Now when you re-run that analysis there will be two more Category Summary for Selected Parts reports in the output, as shown below.

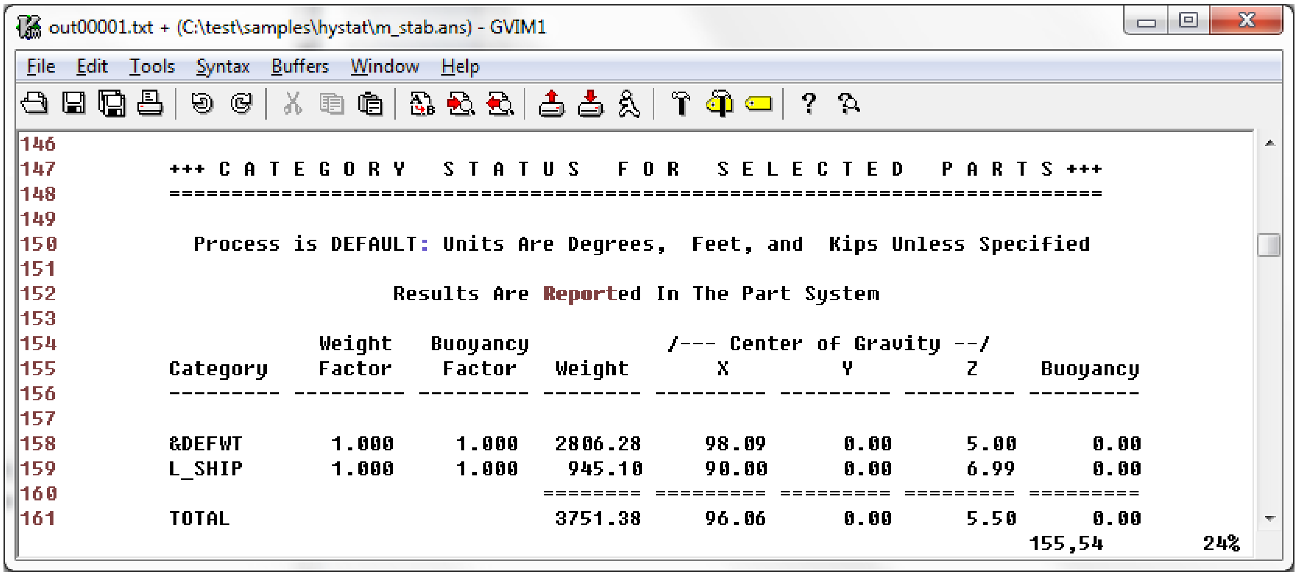


Figure 6: Results Before the KG_ALLOW command

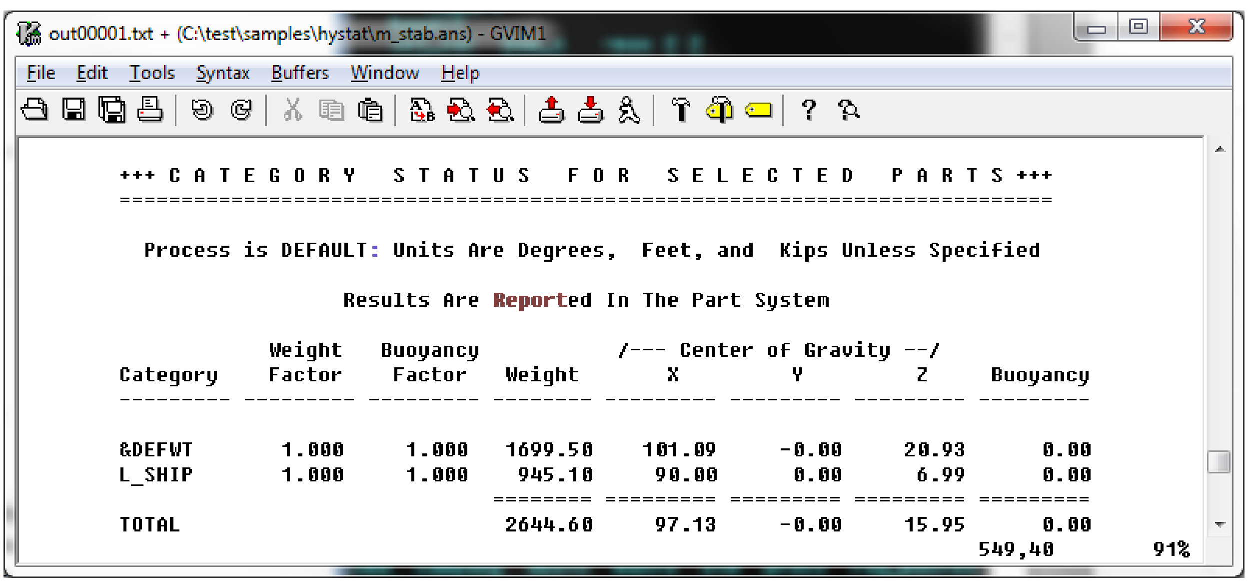


Figure 7: Results After the KG_ALLOW command

The report before *kg_allow* shows the weight &DEFWT with a ZCG of 5.00 ft and the report after the *kg_allow* shows the weight &DEFWT with a ZCG of 17.12 ft and the VCG of the barge system at 15.95 ft. This answers the question from above. If we want to know the allowable KG for the system, we have to somehow turn off the L_SHIP weight.

Exercise B

Find the allowable KG of the system. You are looking for an allowable KG for a 6 ft draft. Check both intact and damage (comp. 5P) and for 0 and 45 degree yaw.

You will need the following command to turn off the category l_ship.

```
&apply -percent -cat l_ship @ 0
```

2.5 Review: Working with Compartments

Topics:

- Programing MOSES
- Introduction to macros
- Introduction to loops

Reference files: /ultra/hdesk/runs/tests/compart/gm.cif, gm.dat

Discussion

The purpose of this exercise is to present some programming techniques available with MOSES. We use many of the commands that control the compartment properties and reporting of the compartment properties. This is meant as a programming exercise not an engineering exercise.

Let's start by reviewing the commands in the cif file. The first command is *&status v_hole*. The *&status* command has been used in previous exercises. Here we are going to look at the various types of reports which *&status* command can generate. The first instance here reports the status of the valve holes. Valve holes include vent and flood valves. In the report generated by the *&status v_hole* command there are three types of valves listed: vent, f_valve, and m_vent. You can read more about these types at

http://www.ultramarine.com/hdesk/ref_man/cmp_int.htm#&DESCRIBE

Here is the introduction to macros. A macro is a way to add your own commands to MOSES. If you find yourself using the same set of commands over and over again, then perhaps, a macro will save you time and effort. Here we are adding the command *st_cmp* (only for running the gm MOSES session).

If you go to the dat file, you will see there is a section that begins with *&macro* and ends with *&endmacro*. This command simply tells MOSES to execute the six varieties of the *&status* command and if the variable "force" is true two more reports will be added. This exercise is intended to introduce the concept of macros. There is a later exercise where the details of macros are discussed.

This is a simple macro, where all we do is reduce the number of commands to one command. The only hard part about this macro is the logic in the "force" variable. When MOSES encounters the command *st_cmp* it knows to execute the commands

&status
&status compart
&status cg_compart
&status s_compart
&status p_hole

&status nwt_down

MOSES will execute these commands no matter what. If you see the IF statement MOSES looks for a variable "force" to be true (or turned on) to execute the commands

&status force
&status config

So, if the command *st_cmp* is encountered the variable "force" is set to false (turned off). If the command *st_cmp –force* is encountered, the variable "force" is set to true (turned on). In other words, when we use "st_comp", the variable "force" is set to false. When we add the "-force" option and use the "*st_cmp -force*" the variable "force" is to true.

There is a whole exercise dedicated to macros. If this does not make sense now, be patient, macros will be discussed again.

Up to this point in the gm.cif file we have asked for report of the valves, set the condition of the vessel, asked for a set of status reports, computed a weight to be at equilibrium, and asked for the same set of status reports. This gets us to line 18.

The next section does have two new commands *&loop* and *&endloop*. This is the first of two loops in this exercise. This is a simple loop which performs the commands between *&loop* and *&endloop* twice. The only difference in the results is that in the second time through the loop there is water in the compartments. The reports generated with *&status* show this difference in weight.

The next section of commands fill the compartments in different manners. Before the compartments are altered, the defined weight (the weight defined earlier with *&weight –compute*) is set to zero with *&weight –define 0*.

The first type of fill is labeled "simple". The second set is labeled as "slosh". In reality these two generate the same results. In the first one we do not specify a fill type. Since "correct" is the default the answers are the same as when we specify "correct". Other fill types can be found in the manual under the *&compartment* command.

The third type is "flood". And here the macro is used with the "–force" option. This "–force" options sets the variable "force" to true. There are two more reports generated for this section, in comparison to the two previous.

The section labeled "test cg loc x" resets the condition, and generates the reports with and without the "–correct" option.

The last part is labeled as "test ullage sound". Here we use a loop and a string function. If you look up the command *&loop* in the manual you will see one of the formats is:

&loop INDEX BEGVAL ENDVAL INCR

Loops are like "while" statements in FORTRAN. The index or variable that gets incremented is "k". The beginning value is 0. It increments by 1 and stops at 20. Here the compartments will be filled in 1/20 increments. The log file will show the sounding for each 1/20 increment for tankp1.

When k = 0, the compartments are empty ((100*0)/20 = 0). When k = 1 the compartments are filled to ((100*1)/20) 5 percent . Then three variables are set each time through the loop. The variable "s" is set to the results of the string function *&compartment(tankp1 -sounding)*. The variable "u" is set to the results of the string function *&compartment(tankp1 -ullage)*. The variable "s" and "u" will be set to a string with three tokens, or you can think of it as a sentence with three words. The first word will be the compartment name "tankp1" the second one will be sounding or ullage (so this will be a number), and the third word will be the specific gravity of the contents (again this will be a number).

We are interested in the second token or the second word. The command *&token(2 %s)* resets the variable "s" to just the second token (the second word) or in this case the value for sounding. Reporting of the ullage is done in a similar manner. And finally the results are typed to the log file.

Exercise

Start with the files wcomp.cif and wcomp.dat from Basic Stability exercise.

Find stability as you did in "Stability Check and KG Allow" exercise for a 5 ft draft. Check the following criteria for both the intact and the damage case.

GM >= 9 ft
Area Ratio >= 1.4
Zero Crossing <= 10 degrees
Range to 2nd intercept >= 30 degrees

Questions

1. Check intact stability for 100 knot wind. pass/fail ?
2. Check damage stability for 50 knot wind, damage compartment 5P. pass/fail?
3. What is the weight of the vessel?
4. What is the VCG of the system?
5. Which compartment(s) has the highest %full?
6. Which compartment(s) has the highest amount of water for this draft?
7. Which compartment(s) has the maximum capacity?

2.6 Dynamic Flooding

Topics:

- Dynamic flooding of a compartment
- Setting the initial pressure in a compartment

Reference files:

- /ultra/hdesk/runs/tests/compart/sink.cif and sink.dat
- /ultra/hdesk/runs/samples/how_to/up_damage.cif and up_damage.dat

The two sets of files are intended to complement one another. In the sink analysis a barge compartment is dynamically flooded. In the up_damage analysis a tubular jacket leg compartment is dynamically flooded. In both cases the intent is to show how to model water entering a compartment in the time domain. The potential uses for this set of commands is the dynamic flooding during an upend and the accidental damage to a compartment.

Sink Dat File Discussion

Let us begin with discussing the dat file. We have two new parts of the barge defined here: the draft marks and the valves.

The draft mark definition start with the comment "*** draft marks". In real life vessels have vertical lines painted with numbers so that the draft can be easily read. What we are going to do here is to make several lines perpendicular to the xy plane. MOSES will use these lines to report the draft at that location of the vessel.

In the file we have put a total of four draft marks. Two draft marks at the bow and two at the stern, two on the port side and two on the starboard side. The first step is to make the nodes. Here we have employed a naming convention, the first character is "b" for bow, "s" for stern, the second character is "s" for starboard, "p" for port, and the third character "b" for bottom and "t" for top. Making a total of eight points for four lines. Following this convention the point *bsb is a point located on the bow starboard bottom.

To actually define the draft mark lines, we use the *&describe body* command again. Please keep in mind that you need to <u>first</u> define the body, then define the nodes to use for the draft marks, then use the *&describe body* again to further add to the body description. Here we use the *–dmark* option. Please notice that each draft mark requires its own *–dmark*.

For the *dmark* option we need to name a bottom node and a top node. Here again we have employed a simple naming convention. The first character is "b" for bow or "s" for stern, and the second character is "s" for starboard and "p" for port. Please keep in mind that the draft mark line must be defined from bottom to top. MOSES will measure from the first node toward the second node. **If you reverse the order then you will be getting free board not draft**.

The second new item we have added to the vessel description is the flood and vent valves. Flood and vent valves are holes on the outer shell that allow water to enter or exit an assigned compartment. This section starts with the comment "*** compartment". In real life they could be vents.

Here we define a node for the vent valve and label it *vent, and we define a node for the flood valve and label it *flood. The defining of the nodes is as done in earlier exercises with the * symbol. By using the command *&describe hole* we are telling MOSES these are holes on the outer shell. For describing a hole, we tell MOSES its type, size, location, and a friction factor. If we were simply doing a static analysis we do not need to tell MOSES the diameter nor the friction factor. In this exercise we will be doing a dynamic flood, we want the flow rate to be correct. So we do need to make sure the areas and the friction factors are correct.

Finally, the last step in defining the valves is to tell MOSES which compartment is assigned to these holes. This is done with the *–holes* option on the *&describe compartment* command.

Sink Commands Discussion

For the exercises up to this point we have been discussing the command file before reviewing the log and output files. For this exercise it will be much easier if we discuss the log file and it contents as we are discussing the commands as they occur in the command file. Please run the analysis and create the log file so that the rest of this discussion can make sense.

Do not tidy, but instead restart. After this restart in the sink.ans directory there will now be a log00001.txt, out00001.txt, and a log00002.txt.

Once the MOSES window appears type CTRL–G.

This should bring up a rendered figure of the final event. With the mouse you can move the green bar near the bottom to left near 0.0. Then, you can press the "Play" button and watch the simulation.

Now we can discuss the commands. For this exercise, we are not going to merely discuss the commands but we are going to review them in the log file, as well.

The commands at the top of the cif file we are familiar with from previous exercises. The first new command we encounter is *&parameter*. The command *&parameter* sets many of the basic parameters in MOSES. Please see the manual page for all the available options.

This is the first time we are going to work explicitly with a Process. In MOSES a process has events. Here we will be doing a time domain process, so we need to tell MOSES how long to make the process and how many events, or how big the steps are going to be. This is what is done with the new *&env* command.

Here we need to define an environment, because the flooding will be a time domain process. Usually when you define an environment the description will include wind, waves, and current, here we are only describing the total time and the time step. And we are naming the environment "null". Please see the manual for all the possible options.

The next command *&compartment* we have seen before, but we have not seen the option *–dynam*. Please notice that in this command we are telling MOSES three things:

Option	Description
-correct	to calculate the CGs and the derivatives at each event in the simulation
-percent	to empty the compartment to 0 percent
-dynam	the compartment will be filled dynamically

There are many ways to model the ballast water in a compartment. For most of the analyses the type "correct" will be what will be used. If you are interested in the other options, please review the other options under the *&compartment* command. The other methods of modeling the ballast water are so rarely used that they will not be discussed here.

A word of caution is needed here. The placement of the command *&compartment* with the *–percent* and with the *–dynam* options should be placed immediately before the *tdom* command. If there are commands between the *&compart* and *tdom* you run the risk of water being added to the compartments unintentionally. The *tdom* command is the time domain calculations. **For dynamic ballasting the starting ballast and the flag to set the compartment to dynamic flooding have to be placed right before the *tdom* command**.

The actual time domain calculations are performed with the *tdom* command. Please note that the *tdom* command is a Main Menu command and at the conclusion of the time domain you are still in the Main Menu. This is different from the frequency domain calculations where it is all performed within the Frequency Domain Menu.

As mentioned earlier a time domain analysis is a process. In order to view the results we need to be in the Process Post Process Menu, *prcpost*. For any analysis in which there is a process you will be able to use this menu.

In general the sub–menu *trajectory* should be available for all the analyses in which there is a process. The other menus we will use here are generally only available for similar analyses, as we have here.

The sub–menu *draft* works with the draft marks we described in the dat file. For future analysis in which you are interested in how the draft changes with event, you will need to describe the draft marks similar to how we did here.

Since this is our first venture into this menu I will use specific examples, but in general a process can have many different configurations. The specifics that work in this example will probably have to be changed if you look at a different process.

The sub–menus categories are *tank_bal*, *hole_flood*, *tank_fld* and are generally available when you change the ballast arrangement during a process.

All of these commands get us to the disposition menu. There are standard reports for all of the sub–menu categories. Here we ask for the standard report, with the command *report*, of all of them. And we ask for plots, with the command *plot*, of the trajectories and the tank ballasting. This leads us to our first exercise. How do we know what numbers to put after the *plot* command?

Up_damage Dat File Discussion

The file can be divided into the four sections.

- definition of the classes, all these begin with the ~ character
- definition of the beams, all these begin with the word *BEAM*
- definition of the joints, all these begin with the * character
- definition of the compartment, section at the bottom with many occurances of the *&describe* command.

The first three sections are needed to describe a jacket. The format is similar to that which one would get after translating a model from SACS format. In general a jacket model is used when structural detail is needed. Strucutral detail is a very broad term and can include anything from weight distribution to joint can definition. For our analysis it is sufficent that the jacket model has structural members that have weight and buoyancy attributes.

When MOSES reads a data file it takes it a while to process all the information. If you will notice the *BEAM* definition which uses the joint definition is before the joint * commands. It is acceptable for the definitions to be out of order in the data file. MOSES takes the information, sorts it, then puts it together.

Towards the bottom of the file the compartment definitions are found. The format here is very similar to that we found in sink.dat. This is the first time we are going to use the *tubtank* command to describe a compartment. We are using the command *tubtank* to model the compartment defined by the interior of the jacket legs. The jacket legs can be described as long cylinders. The command *tubtank* is an easy and computationally efficient way to describe compartments that are cylindrical shaped.

Notice that the compartments are described in SI units whereas the rest of the jacket is described in feet and kips. The use of the *&dimen* command with the options *-save* and *-remember* make the use of mixed units easy to handle.

Up_damage Command File Discussion

Reading the model with the *inmodel* command gets us to the model edition section, *medit*. In this section we are redefining the part coordinate system. When we review the results it would make our life easier if roll was reported along the long axis of the jacket, and pitch was reported along the axis at the base of the jacket and perpendicular to the long axis of the jacket. Up to this point we have not taken any effort to determine what the location of the jacket coordinate system. We are instead going to use the *&describe part* command to define the part system to fit our analysis.

The way we are going to use the *&describe part* command needs a bit of discussion. The command implies that you are changing the part coordinate system. We need to be clear about what the rules are here with the naming convention. When a part system whose name is different from the body then only the part system is redefined. When a part system whose name is the same as the body then the body and the part system are being redefined.

When you read the manual page on the *&describe part* command you will see that the order of the nodes is important. We want the x axis to be from the bottom of the jacket towards the top so that roll is measured along the long axis. This means points 4 and 2 have to be at the base of the jacket and points 1 and 3 at the top of the jacket. We next want y to be transverse on the base of the jacket, preferably on the face floating at the water surface in the beginning event. If you look at the following picture you see the point selection, *J4003 *J4001 *J8003 *J8001 will result in the desired coordinate system. Figure 3 shows shows the locations of the points.

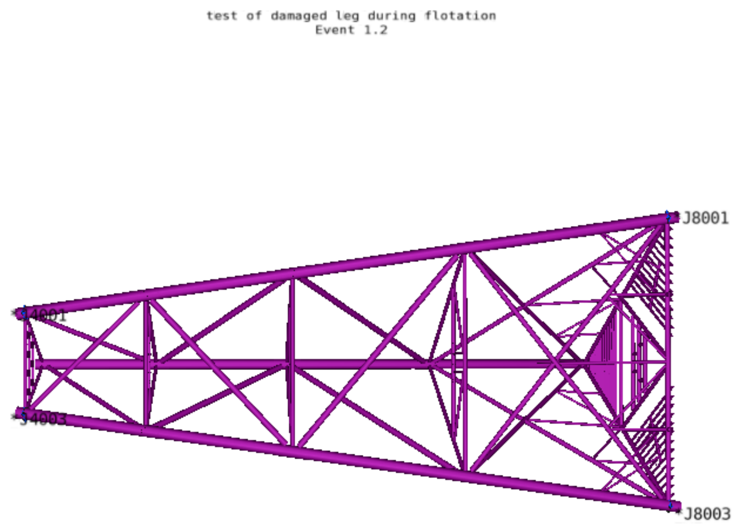


Figure 3: Points used to redefine the part coordinate system

The commands used to create the picture are:

&select :ppp -select *j4003 *j4001 *j8001 *j8003
&picture top -render gl -water no -points :ppp -anotate points

The only thing you will need to do with the mouse is set the event to 1 with the slider bar, and used the up and down arrow keys to zoom in or out as desired.

This is all we need to do as far as editing the model. In the next set of commands we get a summary report of the compartments defined in the data file. We have seen the *&summary* menu earlier when we discussed the allowable KG macros. Here we are asking for a compartment report instead of a category report. As you can see the *&summary* menu is a prepared way of presenties summaries of the database. Following that we use the *&status* command to get the status of the compartments. We have seen the *&status* many times in the other exercises.

In the next set of commands we find the initial floating position. This is the first time we see the *-guess* option used on the *&instate* command. The pair of commands, *&instate* and *&equi* is needed to find equilibrium quickly. This is similar to the previous exercises where we first set the body at a condition (draft, roll, trim) then found equilibrium. The *&instate* command orients the body and the *&equi* finds the position where the sum of the forces and the moments are very near zero. Please keep in mind that for all analysis the program will find equilibrium in a small number of iterations the closer it is to its equilibrium position. That is to say we could have also issued multiple *&equi* commands until the program found an equilibrium position. This plan of action would eventually get us to the same position, however we would probably be frustrated by then.

The results of the *&equi* command show that the jacket is in equlibrium with a slight roll and slight trim. That is to say the body coordinate system is oriented at an 0.03 degree roll and an -0.89 degree pitch with respect to the global coordinate system.

In the next section we report the position of the four points we used to define the coordinate system. Here we are using the string function *&points*. String functions were introduced in the Working with Compartments exercise and will not be further discussed here.

The only point in reporting the positions of the points is to assure ourselves that an equilibrium position close to the one that we anticipated was found. In this section we are reporting the position in the body followed by the position in the global. The reported positions show that there is a slight difference in between the body coordinate system and the global coordinate system. This is showing the difference resulting from the equilibrium roll and pitch.

The next command does need to be looked at a bit closely. Here we are asking for a report of the status of the pressure on the defined holes, *&status p_hole*. Please note that this is the static situation at the current event. All the holes are going to show that their current state is open. Their current state is in a static scenario. We have not told MOSES that we will be flooding dynamically and we currently we have also not told MOSES this is to be associated with an event.

The next command *&status v_hole* produces a status of the valve data. The valve data reported is the hole type, the location, the normal, the friction factor, and the area. Please notice that the coordinate system being used here is our "new" coordinate system that was defined with the *&describe part* command.

From this point forward it should be similar to that which we discussed on sink.cif. In the next command we perturb the system a slight bit and report the position of the bottom of two of the legs. We define an environment so that we can have a time to work with. Then we open the valve and see what happens. Even in the output we report many of the same quantities.

After you run it you will see in the log file that the simulation ended due to capsizing. If you look at the movie you will see that the jacket stays with a face near the waterline until near 65 seconds. Then the jacket begins to roll until it rolls past 90 degrees and the program shuts it down.

Exercise A

Restart sink analysis, and at the bottom window type the commands

prcpost
trajectory
vlist

Hit "ENTER" at the end of each command. Note the title bar changes to show what menu you are in.
After entering the command *vlist* we get a list with 24 entries. From the resulting list we know 1 corresponds to time and 7 corresponds to Z:TBRG. Z:TBRG is understood to be the Z location of the barge coordinate system origin measured in the global coordinate system. This helps understand the numbers after the *plot* command.
In the cif file, the "-no" option is used with the *plot* command. The "-no" option tells MOSES there are no editing changes to the plot that is to be produced.

1. What is associated with 9?
2. When you look at the plot in the sink.ans directory (gra00001.png).
   - What is the legend on the x–axis?
   - What is the legend on the left hand y–axis?
   - What is the legend on the right hand y–axis (RAX)?
3. When you review the *plot* command in the manual, what command do you need to make a plot with the independent variable to be labeled with "EVENT", the left hand axis "Displ:TBRG" and the right hand y-axis to be labeled with "Bot. Clear:TBRG" ?

Exercise B

The sink command file contains a section for reporting the tank flooding.

```
tank_fl
 report
end
```

Add this section to the up_damage command file. When you review the output file for both sink and up_damage you will notice that the columns for Extrnal Fl. Head, Internal. Fl. Head, and Vlv Diff Head are blank for the active compartment. This is caused by the time domain ending abrubtly. When the time domain ends due to capsizing MOSES interprets this as a failed analysis and tries to bring attention to it. There is a message in the log file, and there is this blank in the report that specifically shows what is happening with the dynamically flooded compartments.

In order to avoid this the time allowed needs to change to something smaller than when it capsizes. In the sink command file, change the environment command so that the time simulation ends at 200 seconds. In the up_damage command file, change the environment command so that the time simulation ends at 80 seconds.

&env null –time 200 1

1. Is there a change in the log file?
2. Is there a change in the Compartment Flooding Report?

Exercise C

In the up_damage command file change the flooded leg to be leg 2, the one associated with compartment "two". From the locations of the valves you should be able to determine that leg 2 is the leg not at the water surface. When this leg floods the trajectory looks more acceptable to a controlled upend procedure.

2.7 Basic Frequency Domain Motion

Topics:

- Calculating RAOs
- Reporting motions at a points

Reference files:

/ultra/hdesk/runs/samples/sea_keep/cargo.cif cargo.dat
/ultra/hdesk/runs/samples/sea_keep/rao.cif
/ultra/hdesk/runs/samples/data/pcomp.dat

Discussion

The command file for cargo.cif is very similar to rao.cif.

The files rao.cif and rao.dat are discussed on the Ultramarine web page:

http://www.ultramarine.com/hdesk/runs/samples/sea_keep/rao.htm

It is a good idea to read the entire section on sea keeping that is available on the web:

http://www.ultramarine.com/hdesk/runs/samples/sea_keep/doc.htm

The file cargo.cif are in the /ultra/hdesk/samples/sea_keep directory. This cif file shows how to do a frequency domain motion analysis. This is the first of two exercises that deals with motion analysis. For this first exercise we introduce the concept of parts, in the next exercise the parts will be held together with connectors. Let's start by looking at pcomp.dat file. In the Basic Stability exercise, we used a part but it was not discussed. In this file we are again using the cargo barge cbrg180 from the library. The new part is under the section labeled "add cargo". This section begins with the command *&describe part cargo*. In MOSES a part is defined within the body coordinate system. Here the coordinate system references the barge origin. Please recall that for the vessels in the vessel library the origin of the coordinate system is the intersection of the bow, the centerline, and keel. The command *&describe part cargo* simply tells MOSES that we are going to describe a part and that MOSES should classify it appropriately. A body can have many parts and each part can have its own name. Parts with the same name as the body are referred to as "body parts". It is the intent to show through example how to use body parts and how to use "regular parts".

The part we are going to describe will have a weight and a piece associated with it. The weight is used to define the mass matrix and the piece is used to define wind and current areas to attract wind and current loads, respectively. It is not necessary to define the wind and current areas in this manner. Here we are showing, as an example, how to define wind and current areas by employing a piece.

Let's discuss the commands **, #weight, pgen, plane* and *end_pgen* . The first item is defining the point *car_cg. We need to somehow describe the geometry of our items (cargo) to MOSES. We describe the geometry by a set of points and then we tell MOSES what we want at the points or if we want to join the points to make a surface. Here we are describing the point where the center of gravity of the cargo will be.

We define the weight of the cargo with the command *#weight*. (It is assumed that by this point the student can look up the command format for *#weight* in the online manual.)

To define the cargo we need the mass properties and the geometry description. The geometry description is essentially the piece description. The piece in this case is generated with *pgen*, piece generator. The commands *pgen, plane* and *end_pgen* describe the geometry. Here we do not define points. We are describing the geometry much like a ship plan, and we let MOSES generate the needed points. The numbers 65 to 115 tell MOSES the station locations. Remember these stations, or *PLANE* are measured from the bow. So the first plane will be at an X location of 65 feet from the bow. The option *–rect* describes the station properties. Here there is only one station property so all the stations will be the same. All the stations will have a rectangular shape with the bottom of the rectangle at Z = 15 ft, the top of the rectangle at Z = 30 ft, and the total beam 66 ft. If you look up the format for the option *–rect* you will see it asks for a ZTOP, ZBOT, and a BEAM. In conclusion, we have a cargo shaped like a box with the mass properties of 1000 kips, radii of gyration Kxx = 16 ft, Kyy = 16 ft, and Kzz = 20 ft.

Now let's start talking about the cif file. The first part of the cif file we are already familiar with. We know how to put the barge at the desired draft and trim, we know how to put ballast in a compartment, and we know how to review our set up with the *&status* command and options. The part designated as "stability trans" we have familiarized ourselves with in the first three exercises.

We are going to discuss the general trend of the cif file here in the workbook since the commands in the cif file can be explained by following the web page discussion on rao.cif.

Generating the hydrodynamic database is one part of the analysis that can take much computer time. Strip theory in general is faster than 3D–Diffraction. The greater the number of panels used to define a diffraction mesh, the greater the computer time needed to generate a hydrodynamic database.

In the frequency response menu most of the commands begin with the "fr" or "st" characters. The commands that begin with "fr" compute frequency responses and the command that begin with "st" compute the statistics. What comes after the underscore tells MOSES what quantity we are looking for. Here we used "point" when we are interested in the frequency response at a point. Please note that there is always an "fr" command (the responses have to be computed first) before any statistics can be computed and reported.

Exercise A

Change the file cargo.dat so that line 11 reads.

pgen cargo $ –perm 0 –cs_cur 1 1 1 –cs_win 1 1 0

Compare the changes in righting arm results this change causes. If you look up the *pgen* command in the manual do the changes make sense?

Exercise B

The project has informed you that the transporation will now have two pieces of cargo. Leave the current cargo where it is and add the second one with the following information.

- The dimensions of the cargo: length 50 ft, width 66ft, depth 15 ft.
- The CG is x = 142, y = 0, z = 20.
- The cargo weight is 1000 kips

You are to add the cargo and empty compartments 4p and 4s. You are asked for an updated stability and RAOs.

This is the suggested addition to the dat file. The answers in the answers section are based on these changes.

```
&describe part cr_strn
*cr_strn 0 0 20
#WEIGHT *cr_strn 1000 16 16 20
pgen cr_strn -perm 0 -cs_curr 1 1 1 -cs_win 1 1 0
plane -25 -20 -15 -10 0 10 15 20 25 -rect 15 30 66
end_pgen
```

Changes to the command file.

```
INMODEL
medit
&describe body cbrg180
&describe part cr_strn -move 142 0 0 0 0 0
end_medit

&compartment -percent cbrg180 @0 \
3p 100 1.0255 3s 100 1.0255 \
1p 100 1.0255 1s 100 1.0255
```

1. Did the range change in the stability results? What is the range?
2. When you present the results are you going to make a comment about the resulting condition (draft, roll, trim)?

2.8 Modeling Cargo

Topics:

- Positioning a deck model on a barge
- Stability of the deck and barge system
- Connectors
- Automated transportation analysis
- Motions analysis using two bodies

Reference files:

/ultra/hdesk/runs/samples/install/install.cif , install.dat
/ultra/hdesk/runs/tests/freq_con/twobod.cif , twobod.dat

Discussion

The file twobod.cif is a simple transportation, but without automation. This file also does not do everything the automated file does, but we are going to discuss the commands since most of these commands are also used in the automated tools.

First this is where we introduce connectors. The cargo is being held onto the barge with four generalized springs (gspr). These springs are relatively stiff in all directions (translational 1e5 and rotational 1e4). Notice that the connectors are used to join a node that begins with a *v to a node that begins with a *db. Now if we look at the twobod.dat file we will see that nodes beginning with a *v are associated with barge and nodes associated with a *db are associated with the jacket. In general it is a good idea to have all the nodes in the same body begin with the same character. Also, notice that the connectors are given names (c1, c2, c3, and c4). For connectors and other elements MOSES will provide a name if you do not. In order to make the output easier to read you should provide your own names.

Now lets take a look at where the connectors are defined. Above the *medit* command is the *&instate* command. So, the two bodies are first placed in the desired position then the connectors are defined between them.

When the connectors are defined their initial length is set. In this case the connectors are going to have an initial length of 0.001 feet. Reviewing the dat file we find the barge depth to be 20 ft. The *&instate* command locates it at a 10 ft draft, leaving 10 ft freeboard, and the same *&instate* command places the deck at 10.001 ft. This also places *db0, *db1, *db2, *db3, and *db4 at 10.001 ft. So when the connector command joins the *v to *db there is only 0.001 ft of clearance. When the connectors are placed at a 0.001 ft length their corresponding force is 100 kips. (0.001 X 1e5 =

100)

Next we look at the connector forces to see if they make sense (*&status f_connect*). Then *&equi* finds equilibrium. Finally, we ask for a series of status reports.

The buoyancy and weight reports (*&status*) shows that the buoyancy and weight of the barge differs by 3108 kips. In the buoyancy and weight report of the jacket, we see that the jacket does not have buoyancy and the weight is 3108 kips. The buoyancy and weight reports present the buoyancy and weight at the current location. The force of the connectors is not presented in the buoyancy and weight report.

In the current system configuration report (*&status config*) we see that the system is very near equilibrium. The system is 0.22 kips off. In general, MOSES is going to find a position very near equilibrium. It is very rare that MOSES will find a position where all the forces and moments sum to zero. Still in this report the connector forces are not reported.

In the connector forces report (*&status f_connect*), we see that the connectors have now been evenly loaded with a 777 kips. We find that the sum of the connector forces 3108 kips is the weight of the jacket.

The next set of commands are those we discussed in the Basic Frequency Domain exercise. First we generate a hydrodynamic database, then in the frequency response menu we report some RAO's and motions. The RAOS are first calculated then reported at the frequency response point (fr_point) of interest. Please note that we had to tell MOSES we were looking at the barge body. If we do not tell MOSES what body we are interested in, MOSES will think you are talking about the last body mentioned. In this case the last body mentioned is the jacket.

In the file, we compute some frequency responses and we report some statistics and then we finish.

Exercise A

Calculate the hydrodynamic database for 135 and 180 degrees. Add periods 4, 5, 15, 16, 17, 18, 19, and 20. Find the statistic of the connector forces for an environment

ISSC wave spectrum,
heading 135 degrees,
period 14 seconds,
significant wave height 10 ft.

Questions

1. For the barge at a point x = 200, y = 0, z = 20, for 135 deg what is RAO for the heave / wave amplitude at 12 seconds?

2. What is the Mean+Ave force in the y direction for C2 in the 135 deg heading environment, for a mean period of 14 seconds?

Exercise B

For this you will need to read the documentation on the installation macros. You will need to start with the install.cif and install.dat files referenced in the automated installation documentation. The files install.cif and .dat use the automated installation macros. These are discussed on the web page at:

http://www.ultramarine.com/hdesk/tools/install/s_instl.htm

It would be a good idea to start with install.cif and install.dat and make modifications.

Changes to the install.dat file:

1. Use the deck model in file c_deck.dat. This model should be in the samples/data directory.
2. The deck leg bottom nodes are: *d781L *d787L, *d701L, and *d707L.
3. Use the vessel model cbrg180.
4. Place nodes *d787l and *d707L 12 m from the bow, equi–distance from the centerline.
5. Place the deck on top of 1.53 m tall support cans.
6. The support can dimensions are OD 1000mm with 25mm thickness. Also, use the default tiedown arrangement at node *d781L *d787L *d701 *d707L.
7. The tiedown dimensions are OD 356mm with 19mm thickness.

Changes to the install.cif file:

1. Change .true. to .false. for the variables launch, loadout, and upend.
2. Put the barge at a 1.86m draft with a 0.57 degree trim.
3. Design a ballast arrangement so that you are in equilibrium. Use only compartments 4P, 4S, 5C, 5P, and 5S.

Using the knowledge from the stability check exercise. Perform a stability analysis for the following criteria:

1. draft 1.86 m, pitch 0.57 degrees
2. wind 100 knots
3. minimum intact area ratio 1.4
4. minimum intact area ratio at maximum righting arm 2
5. minimum intact gm 5 m
6. minimum intact area ratio at 40 deg 1.0
7. minimum range of stability 36 degrees
8. maximum angle of equilibrium without wind 2 degrees
9. maximum angle of equilibrium with wind 5 degrees

Review the results and answer the following.

1. Does this stability pass/fail?
2. What is the controlling parameter?
3. What is the weight of the structural elements in the deck model?
4. How much do the set of tiedowns weigh?

Exercise C

Analyze the transportation for the following sea descriptions:

Environment Names	Hs m	Mean Period sec
h	3.7	12.5
s	2.3	8.9
y	3.2	8

Use the wind defaults. The wind options will be discussed in a later exercise. DO NOT perform a structural analysis. Use the same ballast arrangement as that used for Exercise B. You will need to read the vortex report section in the manual. This section can be found at:
http://www.ultramarine.com/hdesk/ref_man/summary.htm#BEAM_SUM

1. What is the weight of each support can?
2. What is the weight of each tiedown?
3. Is vortex shedding an issue for D0000130 class ~DW10 between nodes D46 *d62?

4. What is the total weight of the system?
5. What is the transverse G force for the deck CG for Hs = 3.7m, heading 0 degrees?
6. What is the transverse G force for the deck CG for Hs = 2.3m, heading 225 degrees?
7. What is the transverse G force for the deck CG for Hs = 3.2m, heading 315 degrees?

2.9 Translating from SACS

Topics:

- Introduction to translating from SACS
- Checking the model

Reference files

sac_tpg.cif sac_tpg.dat

ck_sac.cif ck_sac.dat

cnv_ck.cif jacket.sac

Discussion – the long way

The reference files are in the tests directory under the directory convert. The reader should be familiar enough with the ultra directory (MOSES installation directory) at this point to be able to locate these files and place them in the directory they will be using.

Here we present the procedure to convert a SACS model to MOSES format and a suggested method of checking that the conversion was done correctly.

Converting a model is really a simple exercise. It is the checking that needs to be done carefully. If you look at the sac_tpg.dat file, you will notice the first line is a MOSES command and until near the end all commands are SACS commands. The MOSES command at the top reads:

&convert sacs –jright 000 –cright 000

Please see the manual page on *&convert* for a more detailed explanation on the command and the options. The last two lines of the file are END and *&finish*. The END command is the last SACS command and the *&finish* command is the MOSES command. These two lines are all you need in the data file to convert.

Now lets look at the cif file.

The cif file has three lines. The first line is really not needed for the conversion to work, it is put there to make the output easier to read. The command *&device –oecho no* tells MOSES not to echo the data file to the output file. Please recall that in most of the previous exercises the output contained an echo of all that was read in with *inmodel*. This top section in the output can get rather large. In general, *–oecho* should be set to *no*. The only time I set it to *yes* is if I am debugging.

You should be familiar with the last two lines.

These three lines are all that is needed to convert the SACS model to MOSES format. When you run MOSES the new MOSES model will be in sac_tpg.ans/mod00001.txt. (This is if you did not changed your defaults). This completes the converting part of the process.

In order to check that the conversion was done properly we need to look at the ck_sac.cif and ck_sac.dat file. The check files are the minimal checks. Depending on the complexity of the model or what it's intended use is, other checks may be necessary. This exercise is presenting the minimal checks.

If you review the dat file you will see that the first line is needed so that MOSES knows it is a body. These checks are done with the intent of using the models in the installation macros. Since the installation macros add the *&describe xxx* line to the model I do not take the time here to add this line to the mod00001.txt file. In general I do not change the mod00001.txt file.

If you need to convert a file, it would be a good idea to copy these four files to your working directory and then just change the SACS part.

Discussion – the short way

Now take a look at cnv_ck.cif. This file is used to convert the SACS model found in jacket.sac. This uses one of our macros and it makes all the changes and creates the check files for you. Run this cif file and answer the following questions.

Exercise A

1. How much does LOADLC3 weigh?
2. Where is the center of gravity of the elements?
3. What is the total buoyancy?

Exercise B

Start with the sss.inp file. Convert the model call it l_jack.dat. You will need to add the command *categ -brief* to the section within the *&summary*.

1. Where is the center of gravity of the elements?
2. What is the total buoyancy?

2.10 Longitudinal Strength

Topics:

- Longitudinal strength calculations
- Defining a part
- Positioning a part
- Difference between equi and &equi
- Define a point load and a distributed load.

Reference files

p_m.cif p_m.dat

Discussion

The reference files are in the test directory under the hydrostatics tests. The reader should be familiar enough with the Ultramarine web page at this point to be able to locate these files and place them in the directory in which they will be working.

Both of these files are rather short. Most of the discussion will focus on options for the command we are already familiar with. We will start by discussing the dat file. The first new option we see is the *–location* and the *–section* being used with the command *&describe body*. The reader can find the manual page that presents this command at:

http://www.ultramarine.com/hdesk/ref_man/bod_par.htm#&DESCRIBE%20BODY

Please note that we could have used the line continuation and placed both options after one *&describe body* statement. Both methods are acceptable.

Let's discuss the *–section* option, even though it appears second in the file. The *–section* option simple tabulates the section properties of the vessel. The first number is IE. Please note that the units would be the large force – length squared ($kips - ft^2$, $mtons - m^2$, or $KN - m^2$). Remember I is in $length^4$ and E is in force per length squared. The second set of entries is the longitudinal location and the section modulus at that location. Remember section modulus is in ft^3 or $meters^3$.

This establishes the properties of the barge. The *–location* option used prior to this simply tells MOSES the longitudinal locations we want the results of the strength calculation reported.

The next new option is the *–desc* on the *pgen* command. Here we are simply giving a bit of description to the part being generated. Remember PGEN stands for Part

Generator.

The last section may be new, but for those adventurous types that looked through the transportation macros in more depth, this may be familiar. In the last section we describe a part that we name ”cargo”. As the name implies, it is just cargo, not very descriptive. The cargo is simply a distributed weight. When we look at pictures all we will see is the node. The weight is at x = 0, y = 0, and z=0, and the weight is distributed from –0.5 ft to +0.5 ft. The distribution was done with the *–ldist* option.

The only other thing worth noting is that the part cargo is being defined within the body barge coordinate system.

Now we are ready to discuss the cif file. The first new command is *&describe part cargo –move 200*. Here we are moving the cargo from the location x = 0 to the location x = 200. Please note that we did not move it transversely nor vertically. When we view pictures we are going to have to look at the keel to find the node belonging to cargo.

We have seen the *&weight –compute* command. We are familiar with using the *hstatic* command to enter the Hydrostatics Menu. This is the first time we see the *equi* and the *moment* command. There is a difference between the *equi* command in the Hydrostatics Menu the *&equi* general command. Please see Exercise A for an example on how the two equi commands are different.

Exercise A

1. Add *&status b_w* after the *equi_h* command.
2. Run the file and review the log file.

You should see that the *&weight* command added 20589.23 kips at x= 200 ft, y = 0 ft, and z = 30 ft. Add to p_m.cif

```
medit
&describe body barge
&describe part barge
*bcg 201 0.5 30
♯weight *bcg 20589 32 129 129
end_medit
```

1. Comment out the *&weight* command in the cif file.
2. Add *&status config* before and after the equi command.
3. Run this analysis.
4. Copy p_m.cif to p_m2.cif.
5. Change *equi_h* to *&equi*.
6. Add at the top of the file *&device –auxin p_m.dat*.

7. Run this analysis.

Compare the results in the log file. Note the different residual forces in the status config.

Questions What is the difference in the results of the two different equi commands?

Longitudinal Strength Discussion

In this exercise we are going to examine the command *moment*. This command was presented earlier in the Getting Started Exercise.

Here we have a similar structure as with the *RARM* command we saw in Basic Stability Exercise. The moment command does have options, here we are using the defaults. Please consult the manual to find out more about the options. It is assumed that the user, that has progressed to this exercise, can find this manual page on the *moment* without there being a link provided here.

Let's review the new part of the output, specifically the Longitudinal Strength Results. The shape of the curve, is this what we expect? Let's also examine two simple force distributions to see what is being presented.

First, let's evenly distribute the weight of the barge and the cargo weight along the entire length of the barge. Since our barge is a long rectangular shape, the buoyancy force is evenly distributed along the length of the barge.

Exercise B

1. Copy the p_m.dat file to testb.dat.
2. Copy the p_m.cif file to testb.cif.
3. Add a plot to the moment report.

```
moment
report
vlist
plot 1 2 -rax 3 -no
end
```

4 Change the weight commands to read as follows:

```
*bcg 200 0 30
#weight *bcg 20589 32 129 129 –ldist 0 400
```

5 Change the distribution of the cargo weight. See changes below.

*ccg 00 0 0
#weight *ccg 5000 –ldist –200 200

What this does is distribute the weight of the barge and the cargo evenly, along the whole length of the barge.

Does the shear and bending moment curves also show this?

Exercise C

1. Change the weight commands to read as follows:

*bcg 200 0 30
#weight *bcg 20589 32 129 129 –ldist 180 220

2 Change the cargo weight commands to read as follows:

*ccg 00 0 0
#weight *ccg 5000 –ldist –20 20

What is the buoyancy force per length ?

Exercise D

1. Change the weight commands to read as follows:

*bcg 200 0 30
#weight *bcg 20589 32 129 129 –ldist 0 400

2 Change the cargo weight commands to read as follows:

*ccg 00 0 0
#weight *ccg 5000 –ldist –.5 .5

Compare these results to the original results from p_m.cif. What is the distribution from the &weight command?

2.11 Modeling a Fender

Topics:

- Working with the Model Edit menu
- Working with Generalized Springs

Reference files

fender.cif fender.dat

These files show how to use generalized springs to model the connection between two bodies. The two barges are positioned along side each other (the centerline axes are parallel). Generalized springs are used to define the fenders between the two vessels. A short command sequence to test the fender definition is presented.

The data file is two rectangular bodies. The user should be familiar enough with the modeling language so as to not need this file explained. The stability check exercised presented the modeling launguage. Please refer to this exercise if you are unfamiliar with the language presented in the fender.dat file.

Discussion fender.cif

This is the first time we set the location of two bodies with one command. You can see the *&instate* command is used with two *-locate options*. The barge beams are 15.85 meters for body barge and 27.3 meters for body tanker. The minimum distance between the two 43.21 (15.85+27.3) meters The instate command leaves the centerline of body tanker at x = 0 and y = 0 in the global coordinate sytem and leaves the centerline of body barge at x = 180, y = 45.2 m in the global coordinate system. This definition leaves a 2 meter distance for the fenders. This places the barge port side shell at y = 29.35.

On most commands it is acceptable to have the list of multiple options. The same can be said about the *&weight* command, which follows. These two commands have been discussed in previous exercises. The only addition here is that we are using them to define properties of two bodies instead of just one. Please note that this analysis progresses only through the static analysis, therefore it is acceptable for the values for the radii of gyration were to be left at 1.

The generalized springs (∼GSPR) are connectors which means we need add to the model. We therefore we need to enter the model edit menu. We enter the model edit menu with the command *MEDIT*.

As you may have guessed in the model edit menu some of the commands that we have thus far used in the data files we will be using here to add to the model. The first command, which is familiar to us, is *&describe body*. And to define the points we use the *

This file also comes with notes imbedded within the file itself. The first set of notes address some assumptions about how the fenders are going to work. Here is the contents of the note.
$ NOTE:
$ Remember, when defining locations for fenders (compression only
$ gsprs), no force will be generated until the 2 nodes are touching
$
$ Fenders should be located at the waterline alongside the ship, so the
$ point defined should be outboard the vessel by the diameter of the
$ fender
$
$ Assume the fender is 2.05 meter in diameter, and B/2 is 27.3 so the
$ location of the fender point will be 27.3+2.05=29.35
$
$ For demonstration, I'm making a simple assumption that the tanker is
$ wall-sided. This may not be true.
$

This is a good time to point out that the power of MOSES is in its ability to be programmed. Part of the burden of programming is leaving enough documentation so that other people or even yourself after a few months can easily return to the command file and us it with minimal effort.

We do need to address syntax here. In MOSES the comment character is $. MOSES will ignore all characters in the command after it reads the $ character. Please be aware, that some commands can be structured so that they occupy several lines of text, but when you view them in terms of a command item the lines are a continuation of the command. For examples the *&instate* command we used earlier to define the location of both bodies occupies two lines. A comment after the \ would tell MOSES to ignore the locationoption for the barge.

The note is telling us that the fender attachment point on the body tanker is located at y = 29.35, or 29.35m on the starboard side. This locates them y = 29.35 in the global coordinate system. These are all the points that begin with the five characters *fent. In the next section we find the attachment points on the barge. These are all the points that begin with the five characters *fenb. The note is telling us that the fender attachment point on the body barge is located at y = -15.85, or 15.85m on the port side. This locates the barge attachment point at y = 29.35 in the global coordinate system.

If you take into account the x location of the body barge you will see that the four attachment points on the barge are defined at the same global location as the four attachment points on the tanker.

This leads us into the connector definition. Defining a connector consists of two steps: first you define the class then you define the connector. For the fenders we are going to be using generalized springs which are listed under the Flexible Connector Classes. The manual page on flexible connectors can be found at the following link.

http://www.ultramarine.com/hdesk/ref_man/cls_flx.htm

The format and the use of the command that we are working with is:

~CLASS, GSPR, SENSE, DF(1), SPV(1), AF(1) . . . \
DF(n), SPV(n), AF(n),

~fend GSPR compression x 100 2000 y 1 2000 z 1 2000

Here the name of the class is ~fend. The ~ is part of the name. We are defining a compression element with a spring constant K = 100 $mtons/m$ in the element x direction. The maximum allowable force is 2000 mtons. In the element y and z direction have a spring constant K = 1 $mton/m$ and the maximum allowable is 2000 mtons. Basically the element has the element x direction as the strong axis. Which means that we need to be clear about what is the element x direction.

For the definition we need to look a the *CONNECTOR* command.

http://www.ultramarine.com/hdesk/ref_man/conn_rest.htm#EULER

By default, the element system is aligned with the body system of the body to which the first node belongs. The use of the *-EULER* option changes the element system. For our set up the first nodes are the nodes associated with the body tanker. For the body tanker the x is defined bow to stern, the y is defined port to starboard, and z is up from the keel. The origin is the intersection of bow, centerline, and keel.

In the definition of our fender ~*GSPR* connectors we are using the option *-euler 0 0 90*. Which means that the element x direction will be parallel and in the same direction as the body system y direction. The notes within the command file also explain the system change.

This concludes the connector definition. We therefore exit out of the Model Edit menu with the *END_MEDIT* command.

The remainder of the file tests our set up. The first report is a geometry report, *&status g_connector* to check the connection locations. This report tabulates the connection points for each body in each body coordinate system. This report presents the location of the ∗fentX and ∗fenbX in the local body coordinate system.

In the rest of the commands we move the barge along the global y axis and report the forces. The force should increase when the distance between the barge and the tanker is less than 2.05m. Meaning that the connector is in compression. The force should remain at zero when the distance between the barge and the tanker is larger than 2.05m. Meaning that the connector is in tension. Since we have defined our *GSPR* to be a compression element only, then for any positive forces it should be turned off.

For all of these moves we are going to be using the F = kx basic equation. In the inital position x = 0. The force reported with the *&status f_connect* command shows that the force in each fender is also zero. Every move is done in a set of four lines. The results of the four line command are all placed in the log file. They are all similar to the first set, therefore only the first set will be discussed in detail.

```
&type
&type connector force - barge 1m towards tanker
&instate -move barge 0 -1 0
&status f_connector
```

The first *&type* writes a blank line. The 2nd *&type* command leaves a short message in the log file. The purpose of the messages is to make the log file easier to read. If a group of tables are presented one right after another and the only thing distinguishing them is the values it helps to leave a short message to keep track of why the values are different. The *&instate* command moves the barge in the global y axis. Some of the moves are in the negative direction some of the moves are in the positive direction. The last command *&status f_connector* reports the forces in the connectors. For our case, it reports the forces in the fenders.

The first move decreases the distance between the two bodies. The barge is moved towards the tanker by 1 meter. The forces on the connectors report shows a force of 100 mtons. For the second move it again decreases the distance between the bodies. The last three moves it pulls the barge away from the tanker. The last two positions report 0 mtons force in the connectors. The 2nd to last position is again for x = 0, the last position the connectors would be in tension.

The command file is exited with the *&fini* command.

Exercise A

Change the orientation of the barge such that the centerline of the barge is perpendicular to the tanker centerline. Place the intersection of the barge centerline and bow at the tankers amidships. Keeping the 2.05m spacing for the fenders. Keep the draft for both vessels as in the original files.

The four fender connectors are going to have to fit within the breadth of the barge at the bow. Space the fenders two on the port side two on the starboard side. Place them 5 and 10 meters from the barge centerline.

You should be able to get the same compression forces as we had with the original files. Remember that compression in the barge coordinate system is going to be a positive x force so you are going to have to define the connectors with a *-euler 0 0 180* option.

3 Advanced Exercises

This is the advanced section of the workbook. It is assumed that the reader does not need to be given a link to the commands in the MOSES reference manual.

It is assumed that the reader needs a discussion on the command structure. The exercise discussions from here on will focus on why the commands chosen were put in the order they are presented and what project questions were being addressed.

In this section you will find commands where I refer to my own preferences. I have tried to be careful and always say that "I prefer . . .", or "the only time I . . ." when I am expressing my habits. I am being careful here because these are my preferences and they will not necessarily apply to your situation or your preferences. Please feel free to change any settings I designate with my preference.

3.1 Basic Mooring

Topics:

- Introduction to connectors (flexible)
- Introduction to Linear Frequency Analysis
- Introduction to Spectral Frequency Analysis
- Introduction to Time Domain Analysis
- Demonstrate some graphic interactive features

Reference files

mp_moor.cif mp_moor.dat

Modeling Discussion

For a general discussion of mooring anlayses performed with MOSES please see:

http://www.ultramarine.com/hdesk/runs/samples/mooring/doc.htm

This file shows many MOSES capabilities. This file is also discussed in detail on the Ultramarine website.

http://www.ultramarine.com/hdesk/runs/samples/mooring/mp_moor.htm

The workbook is a complement to the material presented on the web site; it is not a substitute. The material presented on the web site covers the same file but there are different aspects presented here.

First, we discuss the modeling. In the next exercise we discuss the commands to perform a dynamic analysis.

The reference files are in the samples directory under "mooring". The reader should be familiar enough with the Ultramarine web page at this point to be able to locate these files and place them in the directory they will be using.

We will start by discussing the dat file, since it is rather short. The first new options we see are the *–cs_wind* and the *–cs_curr* being used with the command *pgen* command. The reader should be familiar enough with the manual to find the manual page corresponding to *pgen*. Basically we are telling MOSES to compute the exposed wind and current area and then compute the force based on wind and current speed. If you would like a more detailed discussion please see Wind and Current Force of the verification document located at the following link.

http://www.ultramarine.com/hdesk/document/verify.pdf

I believe that covers the new parts of the dat file. Now for the cif file.

The first new part is the section that begins with *medit* and ends with *END_MEDIT*. *Medit* stands for "model edit". So as you may have guessed, we are going to alter the model. For this exercise there is only one body, TBRG, in our model. So when we edit the model MOSES will default to TBRG. If we had more than one body we would have had to use the *&describe body* command to tell MOSES which model we were editing.

So the first thing we do is define four nodes *MLA, *MLB, *MLC, and *MLD. If you look at the coordinates and look at the dat file, you will notice that the four coordinates are at the four corners of the barge. These four points will be the fairlead locations (where the mooring lines are attached to the vessel).

The next line that begins with a ∼ defines the class. It is important that we understand the concept of class. This is how MOSES associates elements with properties. Please review the entire section at:

http://www.ultramarine.com/hdesk/ref_man/cls.htm

Here I stress that the entire section be reviewed because there are many types of classes, although we will only be dealing with flexible classes in this exercise.

For this exercise we are using the flexible type b_cat. The type of b_cat connects a body to ground, or I like to think, it connects the body to the bottom.

Also I want to clarify that the 4000 ft is the starting length for MOSES. We may ask MOSES to change the length depending on the tension, or horizontal force, or another parameter. The 4000 ft length can be changed, much as in real life the mooring line length can be let out or drawn in.

Now we define the actual lines; a through h. So there are two lines at each corner. Here as everywhere else, if you do not name an item MOSES will provide a name. Instead of having MOSES make up a name we are using letters here to name them. You are free to name them what you like. There is an eight character limit.

That is the end of editing the model. All these commands could have been placed in the dat file. I put them here because of habit. This separates the body model from the connector model. This is because there is normally a need to reposition (as was done in this sample with the *&instate* command) the bodies before the connectors are defined. The repositioning happens in the cif file, so the connectors are defined after repositioning the body in the cif file.

The next section is commented with "Move Anchors". Earlier we let the anchor simply fall into the water, so that they landed 20 ft horizontally from the vessel. The command *&connector @ –a_tension 100* tells MOSES to increase the horizontal distance from vessel to anchor and stop when the tension at the fairlead is 100 kips. There are other entities which MOSES can use to stop the change. Please see the *&connector* manual page.

Notice here that the length of the line, 4000 ft, is not going to change.

Now the next command, *&type*, is very handy. Basically this command is to leave oneself messages in the log file. In the days of slow computers one would be sitting at the computer wondering if any calculations were happening. If we were to stare at the screen wondering if the computer was working for us, this message would let us know that it is. Here this is a very basic use. Later we will be asking MOSES to give us more meaningful information about our analysis.

As you may have noticed, we try to make the cif files a bit easy to read by leaving ourselves messages. The first message was SET BASIC PARAMETERS, and now we have progressed to Mooring Tables. We usually set these messages with a row of *s.

In this section we are going to produce the characteristics of both the mooring system and a single catenary mooring line. The other thing you may have noticed is that we change the left hand margin depending if we are inside a menu. This is not required it just makes it easier to read.

The first command *CONN_DESIGN* enters the Connector Design Menu. Once inside the Connector Design Menu we are going to create a table of the properties of the catenary mooring line name A, and then, we are going to create a report of the properties of the mooring system when the barge is moved in the 90 deg heading. Please see the manual for the specifics of the command.

This is the end of the modeling part of this example.

Please change the file to read:

```
&type Time to End Mooring Design
&device –g_default screen
&eofile
```

Exercise A

Run the file. MOSES should end in interactive mode.

Now type CTRL–G. This should bring up a tab in interactive mode. But the screen will be all blue. This is because MOSES tries to put in all the mooring system. Type

&picture starb –render gl –connector no

This creates a picture of only the barge.

&picture starb –reset

This changes the picture to a wire frame. The picture shows the barge and the mooring system. The following picture is what you should get.

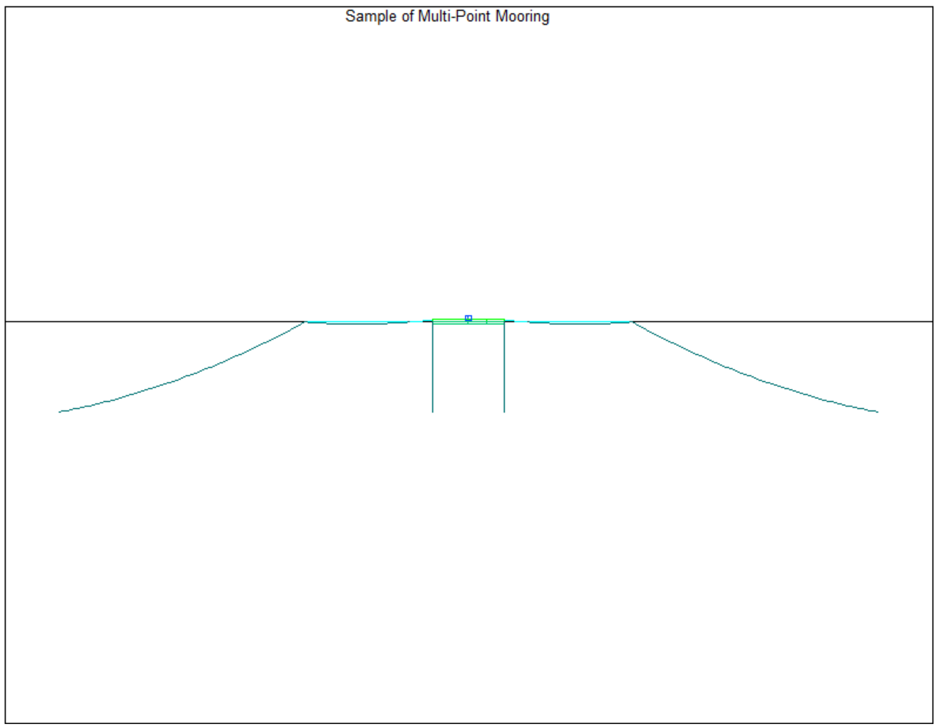


Figure 4: Mooring set up for mp_moor analysis

Type CTRL–F to finish MOSES.

Now let's test some of the descriptions I have written earlier.

Change mp_moor.cif to read:

CONNECTOR h –anchor 45 20 ∼wire *MLA
END
&device –primary screen
&eofile

Now get a rendered picture as you did before.

You will see that the mooring lines fall straight to the bottom and that the anchor is placed about 20 ft from the fairlead. Since at this point we have not told MOSES to move the anchors, this is exactly what the picture should look like.

Preparation for Dynamic Analysis Discussion

Now that we are satisfied with out set up, we still need a hydrodynamic database, environment, and an equilibrium position before any dynamic analysis can be performed.

The next section has been commented as Frequency Domain and was discussed in previous exercises.

Now that we have a hydrodynamic database lets get an environment definition and place the vessel at an equilibrium position.

The next section has been labeled Find Equilibrium. The first command defines the environment. The second commands tries to find an equilibrium position.

The environment chosen name is TEST. Only a wave environment and a time parameters have been defined. Please see the &env command in the manual to see all the other options available.

Here I have specifically written "tries to find equilibrium" because there is the possibility that MOSES will not find equilibrium. You need to keep monitoring the log file and if equilibrium is not found then you need to examine the residuals. There are times for very large bodies an equilibrium is not found but the analysis can continue.

The reason we find an equilibrium position is that we need the mean static offset position. We need the vessel to be placed in a position where the mooring system forces equal the mean environmental force.

For this sample, at the conclusion of this section the vessel is at the mean static offset position. When you are doing your own mooring analysis you will need to stop MOSES here and verify that the mean offset position is acceptable.

The next section has been labeled Define Report Points.

Now depending on what our task is we may be interested in all the points or just a few points. For this analysis we are just interested in reporting what happens to the four fairlead points. So we have told MOSES that the interest points all begin with the two characters *M. The @ sign is the wild character in MOSES. Not only is it the wild character, it also means that any number of character can be substituted.

All the MOSES special characters are discussed at:

http://www.ultramarine.com/hdesk/ref_man/cmd_menu.htm

Dynamic Analysis Discussion

The dynamic analysis portion of the file is separated into the linear frequency domain analysis, the spectral frequency analysis, and the time domain analysis.

Now take out the *&eofile* used for the earlier exercise, and run the entire sample. The discussion will include the cif, log, and out files.

Dynamic Frequency Domain Analysis Discussion

We are going to discuss the two types of frequency domain analyses here. Notice that the frequency domain has its own menu(*freq_response*). Both the linear frequency domain analysis and the spectral frequency domain analysis are done within this menu.

Now lets talk about the Frequency Domain. There is also a discussion on the web site at:

http://www.ultramarine.com/hdesk/runs/c_htm/frq_com.htm

It is important that you understand the difference between the linear frequency domain analysis and the spectral response analysis. We are not going to discuss the theory differences between these two methods. If you would like more discussion on the differences, please read the discussion at the following link:

http://www.ultramarine.com/hdesk/ref_man/freq_rsp.htm#RAO

For both the linear frequency domain and the spectral response analysis we perform the following steps:

- calculate the response
- summarize some of the calculations
- report the frequency response
- report the motion statistics at a point
- report the connector force statistics

The main difference is that for the linear frequency response we use the command *RAO*, and for the spectral response we use the command *sresponse* with many more periods.

In both instances, fr_ is used to report the frequency response. So, *fr* stands for *f*requency *r*esponse.

In both instances, st_ is used to report the statistics at a point and connector forces.

So, *st* stands for *st*atistics. Here we only reported the motions statistics at a point and connector forces. There are other statistics that can be reported, please see the manual command index to get a listing.

Notice that each of these commands enter you into the disposition menu. So MOSES will perform the calculations but if you do not ask for a *REPORT*, MOSES is not going to give you the results. Also, notice that you need to *END* out of each disposition menu. You need to *END* out of the Frequency Response Menu, too.

Dynamic Time Domain Analysis Discussion

Now let's talk about the Time Domain. There is also a discussion on the web site at:

http://www.ultramarine.com/hdesk/runs/c_htm/tdom_com.htm

You will notice that the command structure looks very different. The command *TDOM* is a Main Menu command. Please refer to the manual for remarks on the –*NEWMARK* option. If you examine the log file, you will see that there are twenty messages about the database being saved.

Having brought up the subject of databases, this naturally leads into questions about time step choice, total time choice, and many others. Because a time domain simulation can be performed on many configurations, it is difficult to address all the possible answers one may have on this subject. I would like to refer the reader to the FAQ on Time Domain:

http://www.ultramarine.com/hdesk/question/time.htm

In the frequency domain analysis we had sub–menus to report the results. Here there is a menu for post processing of processes with events. Since the time domain is essentially a collection of events, we will use the *PRCPOST* menu. We are going to report all the results within sub–menus of the *PRCPOST* menu.

There are similarities to what we had done before. We will have to issue a *REPORT* command to get the standard report within the Disposition Menu, and we will have to end out of the Disposition Menu.

For the *points* disposition, we have 133 variables. The number of variables here will really depend on how many points you are interested in. For the command *points* it would be best to always ask for the variable list, *vlist* choose the variables you are interested in reporting, then rerun the analysis. For an analysis with more bodies or more mooring lines you may want to first run the time domain for 10 seconds and get your variables, then run for the proper length of time, and then review your output.

Depending on the number of bodies in your analysis, you may want to do this for all commands in the *PRCPOST* menu.

There is a new command in the Disposition menus under the *PRCPOST* menu. In the frequency domain Disposition menus, there were the commands that began with the characters "ST" to report the statistics, in the PostProcess menu we have the command *STATISTICS*. It is because the number of available variables can change with each analysis that a standard set of column headings for the statistics report was not developed.

Please notice how the *statistics* command uses the numbers listed by the command *vlist*. The Disposition Menu has other ways for to present the results. The most popular being *extreme* and *plot*. Please consult the manual for these two commands.

Exercise B

Change the anchor location in the bow lines so that the pretension is 70 kips. Change the environment description so that the time step is 0.5 seconds.

1. Make a plot of event vs. FY:TBRG.
2. What is the extreme clearance for point *MLC?
3. What is the mean of the Z location of the barge?
4. Make a plot of event vs. force magnitude on mooring line B.

3.2 Transportation Analysis

Topics:

- Transportation anlaysis with native MOSES commands
- Transportation analysis using MOSES tools

Reference files

two_native.cif, two_native.dat, tow_brg.dat, tow_jkt.dat, ..\data\env.dat, tow_auto.cif, tow_auto.dat

Discussion

This exercise presents a transportation analysis in two methods. The analysis is done with native commands then the same analysis is done with the installation tools. The analysis done with the installation tools is considered more complete. The objective in presenting both methods is to show some of the steps that the tools are using, and to show if you wanted to go "the long way" you could. An effort is made to make the order of the output file reports in the native command results mimic the order of the output file reports in the installation tools output file.

The output is presented in three general sections. The first section presents a summary of the models. The second section presents the motions results. The third section presents the structural anlaysis results.

For both analyses, we will be looking at the forces, and structural solution of a square looking jacket being transported on a rectangular barge. This is a rigid barge analysis. The jacket should be placed 200 ft aft of the barge bow and 5 feet above the barge deck. There will be supports between the barge and the jacket to transfer forces from the jacket to the barge.

The file also contains comments to explain what is being done. The discussion here is meant as a complement to those comments. This discussion assumes that the reader has the data, command, log and output files available. Many of the commands used have been discussed in previous exercises. This discussion assumes the previous exercises have been read.

Model data file tow_brg.dat and jacket.dat

The same barge and jacket data files are used for both analyses. The barge data file conforms to the requirements for being in the MOSES library. To see the requirements for being in the MOSES barge library please go to the following link.

www.ultramarine.com/hdesk/tools/vessels/vessels.htm

This is a rectangular barge, length = 300 ft, width = 90 ft, and height = 20 ft. Only the outer shell was included in the definition. It has five points defined with the name begining with a *v. The origin of the barge is at the intersection of the centerline, bow, and keel. The body has a name of "tow_brg". You will see that in tow_brg.dat, line number 71, the command reads *&descirbe body %vname* . In the file tow_brg.dat you will need to return to line number 38 to see that the variable "vname" has been set to "tow_brg".

The jacket is a space frame that looks like a square. The jacket is made up of 12 members (only 6 of them were named). There are eight points defined. A point used as part of a beam definition becomes a node. And a node used to define more than one beam is a joint. The terms "point", "node", and "joint" will be used interchangeably. For the jacket all the nodes\points begin with "*d". There are a total of eight points defined to join 12 members. Only 6 of the members were given names all starting with "b". Point *db0 was set at the origin x = 0, y = 0, and z = 0. The jacket is part of the body "tow_brg". In jacket.dat line 6 reads *&describe part jacket*.

Native Commands Method

Model data file native.dat

The file native.dat consists of two command, *&insert tow_brg.dat* and *&insert jacket.dat*. When we view the two files we see that the order of files in native.dat is important. For this analysis there is going to be one body "tow_brg". The body tow_brg consists of two parts names "tow_brg" and "jacket". The body "tow_brg" has to first be established before any parts can be added. This is why in the file native.dat order is important.

Command file native.cif

Now we will discuss the command file. As with other files the model is read with the *inmodel* command. For this *inmodel* we are useing the *–offset* option. This tells MOSES to take out any "extra" steel that is in the computer model that would not be in the real world. That is to say, the tubular beams are defined from node to node. However when they are welded the steel will have to be offset due to the bracing needing to join the chord at the outer diameter. The distance from the node to the chord outer diameter would be taken out from the computer model with the *–offset* option.

When the models are read in their part coordinate systems are coincidental. What we want is for the jacket to be placed somewhere on the barge deck. After the *inmodel* command we place the jacket origin within the barge coordinate system. This is done with the command *&describe part jacket -move 200 0 25 0 0 0*. Remember that the joint *db0 was defined at the jacket origin. The *&describe* command will put point *db0 at x = 200, y = 0, z = 25 without any rotations. The jacket part x, y, and z axis are still parallel to the barge body x, y, and z axis.

In the next command *&instate -locate tow_brg 0 0 -10 000 0 0* we are placing the barge body (tow_brg body which includes the tow_brg part and jacket part system) so that the barge coordinate system is negative 10 ft in the z direction of the global coordinate system. More simply stated, the barge is being put at a 10 ft draft.

So far we have just moved the jacket with respect to the barge. We have not established any connections between them. The vertical supports (cans) and the sea-fastenings (tiedowns) are defined in the next set of commands. All the cans and tiedowns are refered to collectively as part connectors and are defined within the model edit, *medit*, menu.

For both cans and tiedowns we will be using tubulars of outer diameter 20 inches and 1 in thickness. We have defined two classes "~vert" and "~tiedown" to make labeling easier.

The definition of the vertical support (cans) connectors begins with the command *&describe part can pconnect*. It is important that "pconnect" is included in this command. For the vertical connectors we have convinently left points on both parts that line up vertically to connect. Each of the four vertical cans is defined separately with the command *pconnect*. Basically we are telling MOSES to start with the jacket point and move in the negative z direction to find the corresponding point on the barge. Please note that for the can definition we were explicit about what node on the jacket and what node on the barge to connect.

At this point we compute a weight (can be positive or negative) needed for the body system to be in equilibrium. We confirm this weight calculation with the *&equi* command. Then we define this setup as event 1. This will be the set up used for the still water case later. This is meant to represent the project after loadout but before the tiedowns have been welded.

The definition of the sea–fastenings (tiedown) connectors begins with the command *&describe part tiedown pconnect*. Again, it is important that "pconnect" is included in this command. We will be defining four tiedowns at each corner of the jacket. The tiedowns will have a general 45 degree pattern. On the connector definition we are only specific about which node on the jacket the connector is to attach. For the barge end the wild character is used. This leaves the connection at the barge end up to MOSES. MOSES is going to place the barge end of the connector at 4 ft in the x direction, 4 ft in the y direction, and 5 ft in the negative z direction. From this location it will make a rigid connection to the nearest barge node. How MOSES does this is also discussed in the users manual. Please see the following link.

www.ultramarine.com/hdesk/ref_man/p_conn.htm#PCONNECT

This is all the model editing we will do, so we exit the Model Editing menu with the command *end_medit*.

In the next set of commands we bring the barge body system (tow_brg, jacket, tiedowns, and cans) into equilibrium. The command *&weight –compute* instructs MOSES to add a weight (positive or negative) such that the sum of the forces and moments is within the default tolerance. The weight will be added at 10 ft height from the keel, and the x and y location of the weight will be determined by the moment needed. After this command we confirm the system is in equilibrium with the *&equi* command.

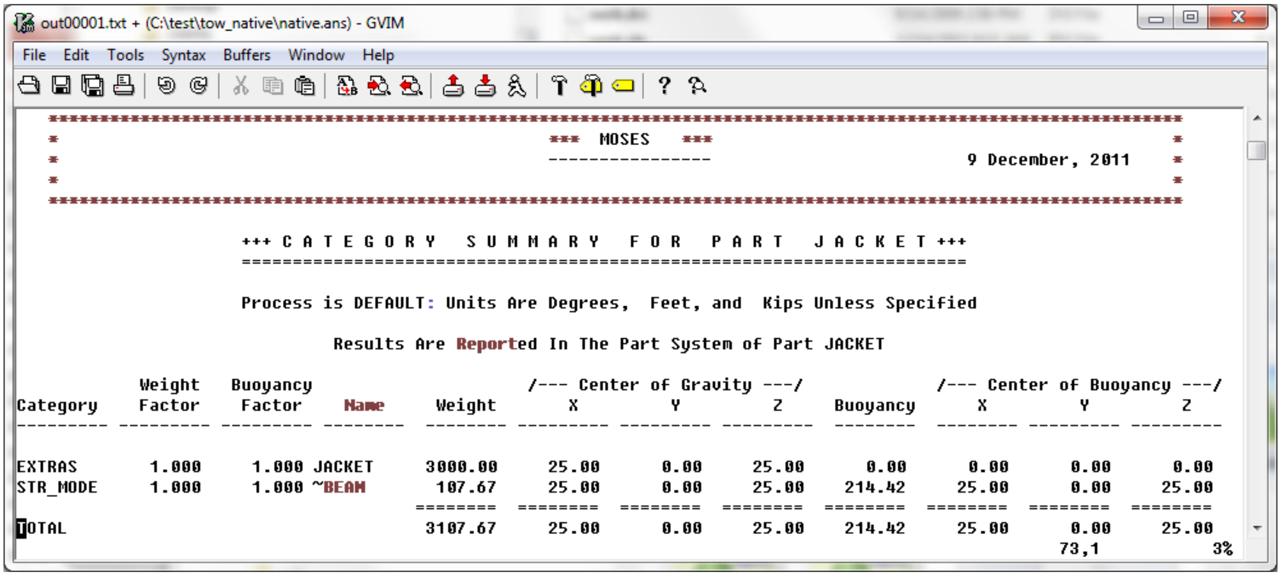
The summary of the input consists of pages 1 through 11. The tables presented in the output file pages 2 through 9 are a result of the commands within the Summary Menu. We enter this menu with the command *&summary*, and exit it with the command *end*.

In this next section of commands we write several summary reports to the output file. The objective we are trying to fill with these reports is to provide verification to the project that the correct model was used and we are providing them to parallel the output from the installation tools. Using the command *&rep_sel -part partname* allows us to present the data that is relevent just for the part we are interested in presenting verification. This makes the output easier to read and hopefully reduces the questions from people reading our results.

For the barge all we report is a Piece Summary, this report provides a very short summary on the vessel particulars. For the jacket we report Category Summary, Wind Vortex Shedding, and Beam SCFs.

For the transportation analysis there is one body and two parts. If you review the output page 3, and shown below in Figure 5, with title **CATEGORY SUMMARY FOR PART JACKET** produced with the command *compart_sum piece* you should also see that the values are reported in the part coordinate system. If you remember the barge part coordinate system has its origin at the intersection of the bow, centerline, and keel. The jacket has the part coordinate system origin at point *db0, which right now is located at barge body location x = 200, y =0, z = 25. If you look again at the table you will notice the column headings indicate where the center of gravity and the center of buoyancy for each item are. Since the part coordinate system for the two parts is different, then reporting them on the same table and then, for the last row, summing the results would be missleading. This is why we want to use the

&rep_sel command for these reports.



*** MOSES ***

9 December, 2011

+++ C A T E G O R Y   S U M M A R Y   F O R   P A R T   J A C K E T +++

Process is DEFAULT: Units Are Degrees, Feet, and Kips Unless Specified

Results Are Reported In The Part System of Part JACKET

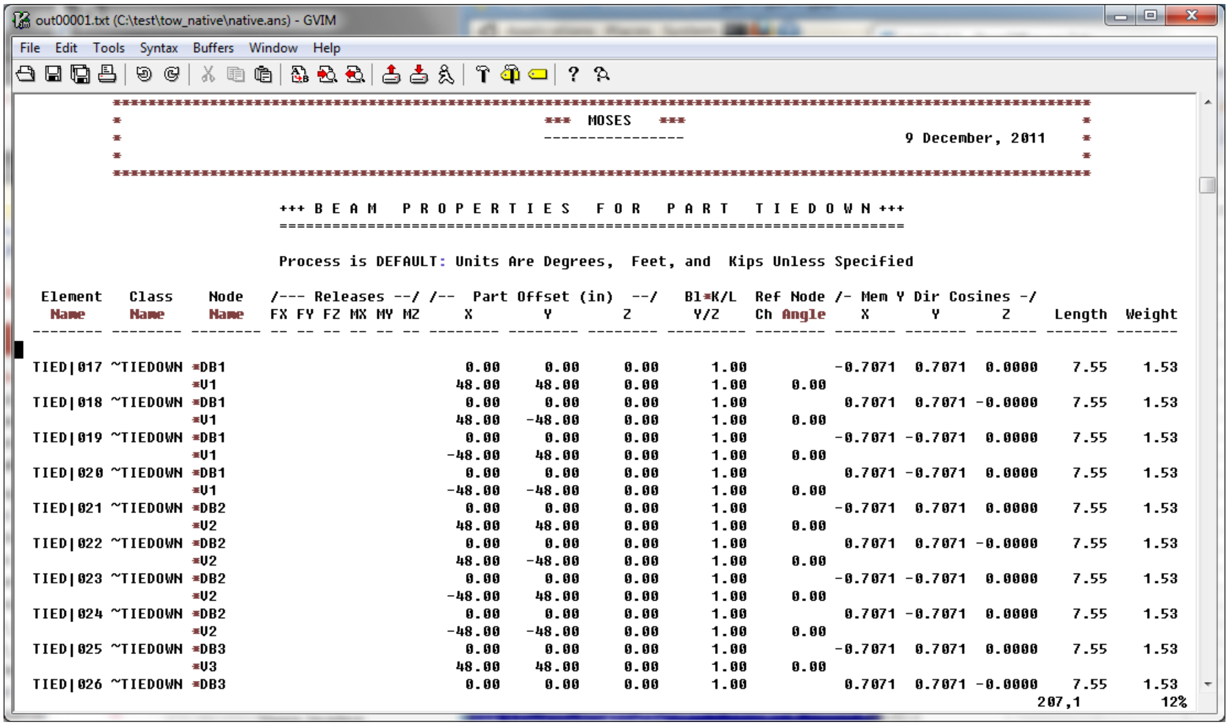
Category	Weight Factor	Buoyancy Factor	Name	Weight	Center of Gravity X	Center of Gravity Y	Center of Gravity Z	Buoyancy	Center of Buoyancy X	Center of Buoyancy Y	Center of Buoyancy Z
EXTRAS	1.000	1.000	JACKET	3000.00	25.00	0.00	25.00	0.00	0.00	0.00	0.00
STR_MODE	1.000	1.000	~BEAM	107.67	25.00	0.00	25.00	214.42	25.00	0.00	25.00
TOTAL				3107.67	25.00	0.00	25.00	214.42	25.00	0.00	25.00

73,1 3%

Figure 5: Category Summary Table

The next report is on classes. Classes do not belong to a part, so the reports titled Class Dimenensions and Material Redesign Properties show classes and material properties for the jacket, the tiedowns, and the cans.

For the tiedowns we have reports titled Beam Properties and Beam Ends. Both of these reports are useful in verifying the tiedowns are modeled as the project desires. The beam properties summary is where we can verify that the tiedown orientation is as input through the use of the member y-direction cosine matrix. For the beam ends report we are given location of each end of the tiedown in the barge part coordinate system. Again please note that we are paying special attention to the part system designation for these reports. We want to be careful and provide proper documentation.



```
out00001.txt (C:\test\tow_native\native.ans) - GVIM
File  Edit  Tools  Syntax  Buffers  Window  Help

  *****************************************************************************************
  *                                        ***  MOSES  ***                                 *
  *                                        ---------------            9 December, 2011     *
  *                                                                                        *
  *****************************************************************************************

                  +++ B E A M   P R O P E R T I E S   F O R   P A R T   T I E D O W N +++
                  ======================================================================

                  Process is DEFAULT: Units Are Degrees,  Feet, and  Kips Unless Specified

 Element   Class     Node    /--- Releases --/ /--  Part Offset (in)  --/  Bl*K/L  Ref Node /- Mem Y Dir Cosines -/
  Name      Name     Name    FX FY FZ MX MY MZ     X        Y        Z      Y/Z    Ch Angle    X       Y       Z     Length  Weight
 -------- -------- -------- -- -- -- -- -- -- -------- -------- -------- -------- -------- ------- ------- ------- ------- -------

 TIED|017 ~TIEDOWN *DB1                            0.00     0.00     0.00     1.00          -0.7071  0.7071  0.0000    7.55    1.53
                   *V1                            48.00    48.00     0.00     1.00     0.00
 TIED|018 ~TIEDOWN *DB1                            0.00     0.00     0.00     1.00           0.7071  0.7071 -0.0000    7.55    1.53
                   *V1                            48.00   -48.00     0.00     1.00     0.00
 TIED|019 ~TIEDOWN *DB1                            0.00     0.00     0.00     1.00          -0.7071 -0.7071  0.0000    7.55    1.53
                   *V1                           -48.00    48.00     0.00     1.00     0.00
 TIED|020 ~TIEDOWN *DB1                            0.00     0.00     0.00     1.00           0.7071 -0.7071  0.0000    7.55    1.53
                   *V1                           -48.00   -48.00     0.00     1.00     0.00
 TIED|021 ~TIEDOWN *DB2                            0.00     0.00     0.00     1.00          -0.7071  0.7071  0.0000    7.55    1.53
                   *V2                            48.00    48.00     0.00     1.00     0.00
 TIED|022 ~TIEDOWN *DB2                            0.00     0.00     0.00     1.00           0.7071  0.7071 -0.0000    7.55    1.53
                   *V2                            48.00   -48.00     0.00     1.00     0.00
 TIED|023 ~TIEDOWN *DB2                            0.00     0.00     0.00     1.00          -0.7071 -0.7071  0.0000    7.55    1.53
                   *V2                           -48.00    48.00     0.00     1.00     0.00
 TIED|024 ~TIEDOWN *DB2                            0.00     0.00     0.00     1.00           0.7071 -0.7071  0.0000    7.55    1.53
                   *V2                           -48.00   -48.00     0.00     1.00     0.00
 TIED|025 ~TIEDOWN *DB3                            0.00     0.00     0.00     1.00          -0.7071  0.7071  0.0000    7.55    1.53
                   *V3                            48.00    48.00     0.00     1.00     0.00
 TIED|026 ~TIEDOWN *DB3                            0.00     0.00     0.00     1.00           0.7071  0.7071 -0.0000    7.55    1.53
                                                                                                            207,1          12%
```

Figure 6: Tiedown Properties Summary Table

Pages 10 and 11 of the output are a summary of the SN curves that will be used for fatigue. These are included as part of the first section summarizing the input. For our analysis we are not changing or adding to this list, but we still need to provide the curves that are used as part of the output. Finally as part of the input summary we make four pictures showing the configuration. The four pictures are created with the *&picture command*.

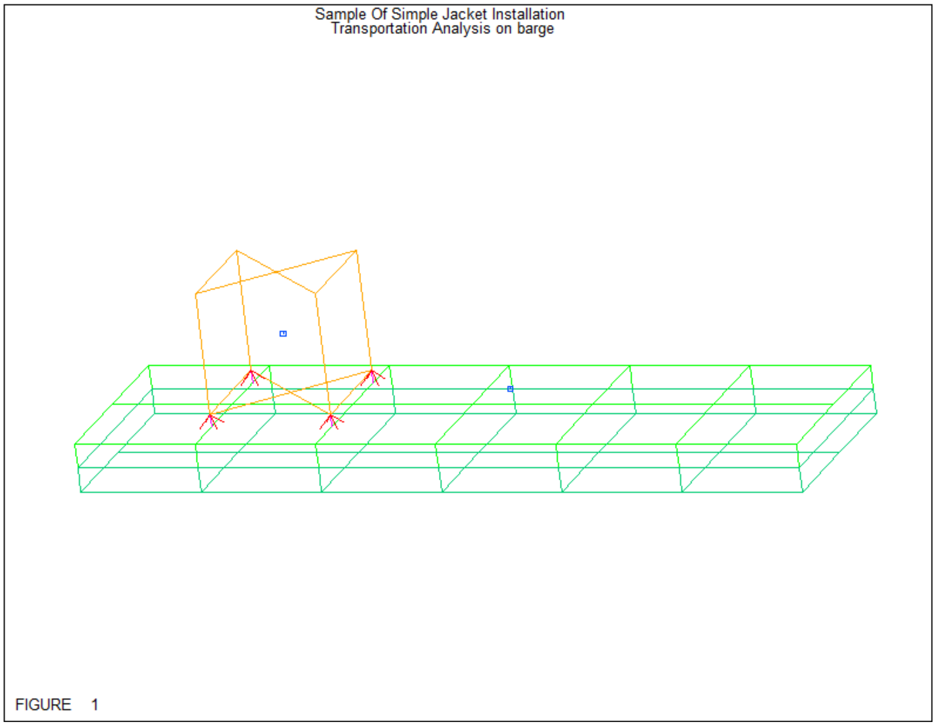


Figure 6: Iso view of Transportation

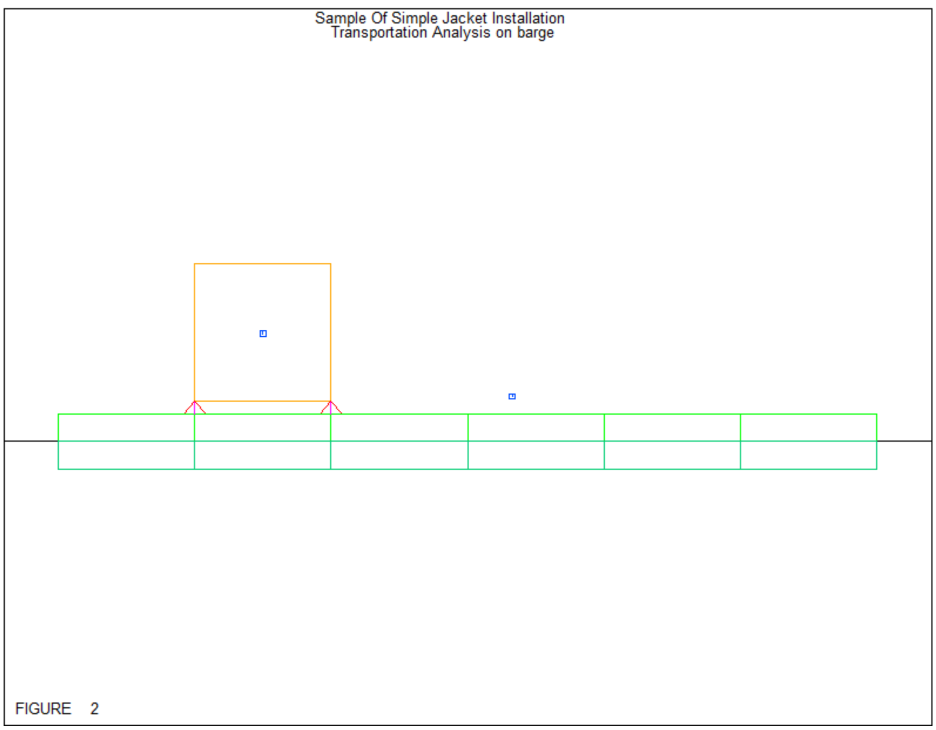


Figure 7: Side view of Transportation

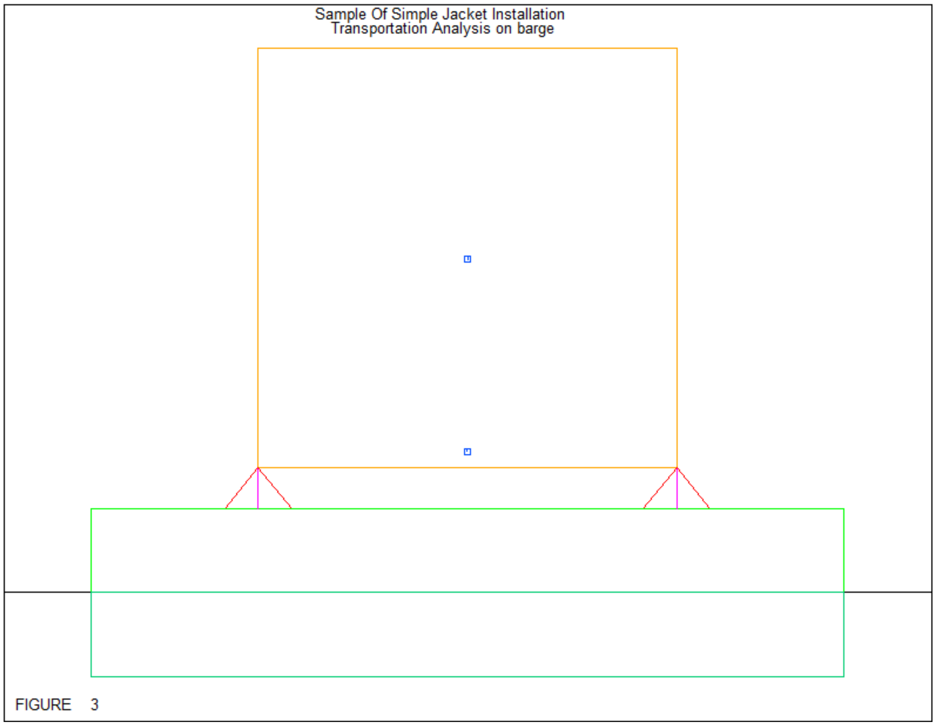


Figure 8: Bow view of Transporation

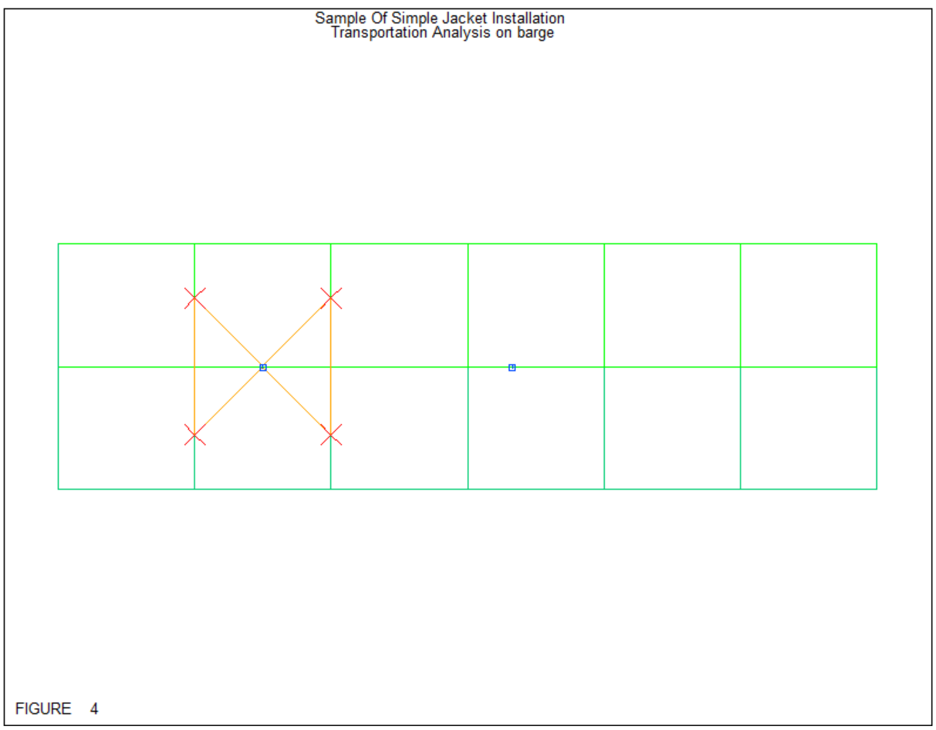


Figure 9: Top view of Transporation

Next we perform a stability analysis. These are the same commands that were used in previous exercises and therefore will not be discussed here.

In the next section of commands we produce a set of tables that summarize the system. Please note that all the values are reported in the barge coordinate system.

The last report Category Summary reports in the barge part system. For this report the structural model has the XCG at 225 ft from the bow. Which makes sence because the jacket is located at x = 200 and the XCG in the jacket part system is at x = 25 ft. The structural weight that is reported in the Category Summary report on page 17 includes the jacket, tiedowns, and cans. Also please note that the command *&weight* added a negative value to achieve equilibrium. The weight added by *&weight* is presented as &DEFWT.

That concludes the static analysis portion of the transportation analysis. Next we do the hydrodynamics and the structural analysis.

Native Command Hydrodynamic Analysis

Creating the hydrodynamic database has been covered in previous exercises. Basically the same set of commands are presented here. Please refer to the previous exercises for a discussion on the commands.

The environments we are going to use need to be given a name. The easiest way to do this is in the *&data environment* menu. Here we are using the same naming convention as that in the installation macros. The first character is a letter designating a Hs and Tm pair, followed by three characters designating the environment heading. Notice that the syntax used for environments in the *&data environment* menu is the same syntax used for the *&env* command. We are going to be using the same environment descriptions for the motions analysis and the structural analysis. Defining them this way, by giving them names, reduces any human error becuase they are only defined once, provides a clean way to write the commands, and can be referenced in the output.

After this we enter the frequency response menu and calculate RAOs and report RAOs at the system CG. When we calculate the RAOs at the jacket part CG we do not ask for a report. Then we calculate the force response operators for the cargo (which happens to be the jacket) and again we do not output the results. This is back to the idea that we are trying to produce the same set of output as the installation tools do.

The next part where we report the G Force Statistics is where we do write reports. The reporting of the G Force statistics is done in numerical and in graphic form. In the output file the statistics are listed just for the nine environmentw defined earlier. In graphical form the period of each of the environments is presented from 4 to 18 seconds. This second part is done with the *–e_period option.*

This concludes the frequency response portion of the analysis. Next we perform a structural analysis.

Native Command Structural Solution

Before we begin the structural analysis we reset the active environment to "none" and we take out the subtitle. This is done to keep the output easy to read.

The structural analylsis presented in the native command file is the basic approach to a transportation structural analysis. The installation macros contain a great deal of logic that better represents the project progression. The default structural analysis performed with the MOSES tools takes care to take out the tiedowns for the still water case then make any mean load cases to include the mean wind force then combine these cases with the dynamic portion.

For the analysis in the tow_native files a much more limited set of load cases is presented. The structural solver menu is used two separate times. The first time for the still water case, and the second time for the wave environment load cases. For both instances we use the same procedure.

- define the load case with *lcase*
- define the restraints to be use with *s_rest*, will leave blank
- define the parts with *s_part* to be included, this changes
- finally solve for the structural solution with *ssolve*

For both times through the structural solver we leave the list of restraints to use blank. For this analysis we are using a rigid barge. The restraints needed to keep the jacket on the barge deck plane are provided by the fact that the barge is rigid. Since we are only performing a structural anlaysis on the jacket, tiedowns, and cans we do not need to include any other restraints.

The first time through we define the "still water" case. This is meant to represent the stage after loadout has finished but tiedowns have not been welded. To do this the list after *s_part* contains only "jacket" and "can" for this load case. The option *–nonlinear* is used. Many times the connection between the jacket at the cans or tiedowns is not welded, there is a possiblity that there could be a temporary disconnect at these locations. This disconnect would make the problem non-linear.

The second time through the structural solver we define the RAO load cases. This just creates the real and the imaginary case for a regular wave and the headings. This does not combine the RAO and the wave spectra. This time through the structural solver *s_part* has "jacket", "can", and "tiedown". This is because the dynamic loadcases are suppose to represent a situation where the tiedowns have been added.

Again at the conclusion of the computation we just know we have done the computations. We will have to go into another menu to get a report of the results. That is what is done with the Structural Post Processing, *strpost* menu. The first thing done in the post processing menu is to combine the RAO load cases with the wave spectra, *cases –spect*. When we review the tables in the output file the load cases will have the names listed after the *–spect* option. This concludes the computations for the structural strength analysis. The rest of the commands control the contents of the output file.

First we make a selector to include all the sepectral loadcases. Then we report the multipiers for the currently defined structural load cases. This is done with *&status*

r_case. The first time through we report all available load cases. This first list is rather long because it includes all the cases created with the *lcase –rao* command. The second time through we report only the load cases we are interested in.

The results of the structural code check are presented in various forms in the last set of commands. Usually a project wants to review the static stillwater case separately from the dynamic load cases. Here we present the results of the code check with the command *beam code –load stillw*. In the next command *beam code –load :load* we get the summary of the results for all the load cases. Here only the case which resulted in the highest code checks is reported. For our analysis there is predominantly H090, but there are some H135 and some stillw listed. Just to show that the other load cases are available the last command *beam code –load s135* presents the results of code check for only the S135 loadcase.

This concludes the strength check of the transporation. The last set of commands computes the fatigue check.

Basically to do fatigue you need to give MOSES the environments and the duration of each environment. For our tow we have all the information in a separate file named env.dat (located ..\data\env.dat0. This file and its format have basically been unchanged for a decade. You need to change the numbers to set the velocity (vel), the total time (tim), and the length (len) variables. After that you define the environments with the first value being the length of time the transportation is exposed to the environment. Usually the meteorlogist will have this information, you will need to somehow put it into this format.

Remember this file is inserted while we are in the structural post-processing menu. When we end out of the *duration* menu with *end_duration* we can just create the fatigue load case with the command *cases*. Then when we return to the native.cif file we just ask for the fatigue report with *beam fatigue*.

After this we exit the structural post-processing menu with the command *end*. The last thing we do is create a picture of the structural solution. The command *&picture iso –type struct –color ratio* creates a picture with the color of each member of the jacket indicating its value in the structural analysis unity check.

This concludes the transporation analysis with all MOSES native commands. Next we are going to use the transportation tools to do the exact same anlaysis.

Automated Installation Tools

If you have not read the online documentation for the installation macros please see the following link.

http://www.ultramarine.com/hdesk/tools/install/s_instl.htm

Our discussion will start with the files from the downlad site, install.dat and install.cif. We are going to start with the install.dat file.

Command file install.dat

The top part of the install.dat file sets alot of variable which are self explanitory, wdepth is for water depth, the SCFs to use are from Efthymiou, etc. The variable we are interested in is "envdat" on line 51. This is the variable that tells MOSES where the environment duration for fatigue is located. We want to use the same file "..
data
env.dat" which was used in the native command analysis. We see that the value is already set to what we want, so we proceed.

The changes we are interested in making begin at line 66. Here we tell MOSES to use the vessel in the current directory in the file tow_brg.dat. Remember tow_brg.dat was created to conform to the vessel library format, therefore this is all we need to tell MOSES when we use the tools.

The next two variable we set are the jacket starboard and the port nodes. If we review the jacket.dat file we see that nodes *db4 and *db2 have positive values in the y coordinate. When we located the jacket on the barge with the native commands we did not rotate the jacket in any manner, so the nodes on the starboard side would have a positive y coordinate. This means that nodes *db4 and *db2 were placed on the starboards side. The order the nodes are placed in is important for these two vaiables. The node listed first is conventionally know as the leading edge. If we were to imagine that this jacket was to be launched the nodes at the barge stern would be at the leading edge into the water. We see that nodes *db3 and *db4 have the largest x coordinate and therefore would have been placed nearest the stern in the native command files. Therefore in our tools file, install.dat, nodes *db3 and *db4 are listed first for the variables. To define the port and starboard nodes we have

*&set port_nod = *db3 *db1*
*&set stbd_nod = *db4 *db2*

This is just the first part in defining the jacket location and sea fastening. The command *model_in* is next used to locate the jacket on the barge. Remember that in the native commands we also placed the jacket coordinate system origin at 200 feet in the x direction. The z coordinate is what is different. Part of the barge library format is to input a variable "vdepth" which is the distance from the barge deck from the keel. Therefore, the distance used to locate the jacket in the z direction is taken from the barge deck. In the native command file we located the jacket 25 ft from the keel, for the transportation tools we will use 5 ft from the deck. The two option used for the command *model_in* use the port and starboard nodes we just designated. For this command *–port_nod* and *–stbd_nod* have the sytax of options, however for this command they are necessary, they are not options. Using the options *–port_nod* and *–stbd_nod* we tell MOSES to place nodes *db3 and *db4 nearest the stern of the barge, and place nodes *db4 and *db2 on the starboard side, and nodes *db3 and *db1 on the port side of the barge. For now that is all we need for locating the jacket on the barge, next we will define the supports and seafastenings.

The next set of commands look very similar to those we used in the native.cif file. To define the support cans and the seafastening tiedowns we will be using the *i_connector* command several times. Within the transportation tools the *i_connector* command and the designators used after it tell MOSES what part is being defined, the orientation, and the connection points. The support cans are defined with the *i_connector v_can* command. Please note that for the transporation tools we were able to list all the nodes that will be supported on one command line. This is different from the syntax used in the native.cif file. The classes are defined with the same command as in the native.cif file. MOSES knows to define a part with a "CAN" name when a connector is defined using the designator *v_can*. The tiedowns are defined with the lines that contain the *pconnect* command. These are basically the same commands from the native.cif file with the command *i_connector* before the *pconnect*. MOSES knows that when the command *i_connector pconnect* is used a tiedown part is being defined.

This is all the information that is needed to produce the same model as the native.cif file. In the default install.dat file that is located in the download site, there are still several commands after the tiedown defintion. Since, they are not needed for the comparison we will not be discussing them here.

Command file install.cif

There are few changes needed to the install.cif file to produce the analysis performed with native.cif. Remember, this discussion assumes you are starting with the install.cif file from the download site.

The first set of changes are in lines 12 to 16. We are only interested in the transportation analysis. This should be the only variable left with a value of ".true.". Please note that the values includes the "." before and after the letters. The values for launch, loadout, upend and lift should be set to ".false.".

The other section we want to change is the options used on lines 33 to 36. In the native file we used wave height and period pairs, 5 and 10, 4 and 11, and 6 and 12. In the native files we had to specify what headings to look at. Here in the installation tools all we have to do is list the Hs and period pair. The installation tools take care of making the environment descriptions for 8 headings (45 degree spacing).

The option *–wind w_inctact w_damage w_vortex w_stuctural* tell MOSES which wind velocity to use for the different parts of the analysis. We tell MOSES to use 100 knot winds for intact stability, we need a value for damage stability even though for our analysis we will not be performing damage stability, a 40 knot wind will be used to check vortex shedding, and 0 knot winds will be used for structural analysis. The installation tools by default check vortex shedding. When we defined our environments in the native command analysis we did not include wind, that is why here we are also not going to include wind and have used a 0 to indicate this.

The last two option *–draft dd –trim tt* tell MOSES which draft and trim to use. We want to make sure we are using the same values as the native command files, 10 and 0.

That is all the changes that are needed to the installation tool files. The tools take care of all the stability, hydrodynamics, and making load cases for us.

Review the answers directory

At this point we have discussed the approach to the native command method and the installation tools method. Some of the log and output file for the native command method was discussed when the native command file was discussed. Here we are going to be mostly reviewing the results of the installation tools method with some comparison to the results from the native commands method.

When we review the results in the answers directory the first thing we notice is that the native commands produced 9 graphics files and the tools produced 22 graphics files. The first five graphics are the same. The first four are shown as Figures 5 to 9 in this workbook. The fifth one is the results of the stability analysis. They are four views of the system and the results of the stability analysis. For the tools results the RAOs are presented in graphical form in graphics files 6 to 13 and in tabular form pages 25 to 32 of the out file. In the native command results only the tabular form of the RAO was produced in pages 18 to 20. Remember in the native command files we only looked at three environment headings, whereas the tools by default will examine eight headings.

The graphs that we can compare are the force response curves. These would be graphics 6 to 9 in the native analysis and some of the figures shown in graphics files 14 to 21 in the installation tools analysis. For the native commands analysis we did 180 deg (graphic 6), 135 deg (graphic 7), and 90 deg (graphic 9). In the installation tools they are just done in a different order, but they are graphics 18, 17, and 16. You should be able to keep track of them by the graphic titles. When you compare the curves you will see that so far we are getting the same answers for both analyses type. You can also compare the numerical results in the output file. In the output file we reported the force response at the jacket CG for just the waves height and mean period that were specified. These are the tables with the title CARGO G FORCE STATISTICS. When making your comparison you will need to make sure the information in the box outlined by *s contains the same information.

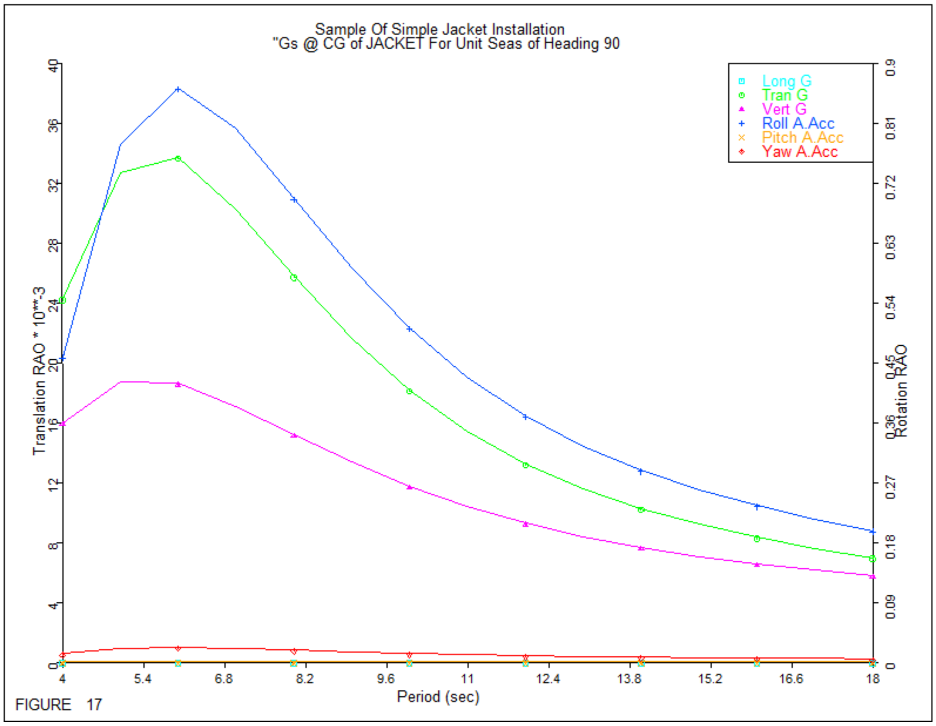


Figure 9: G Force Statistics for 90 deg Using the Tools

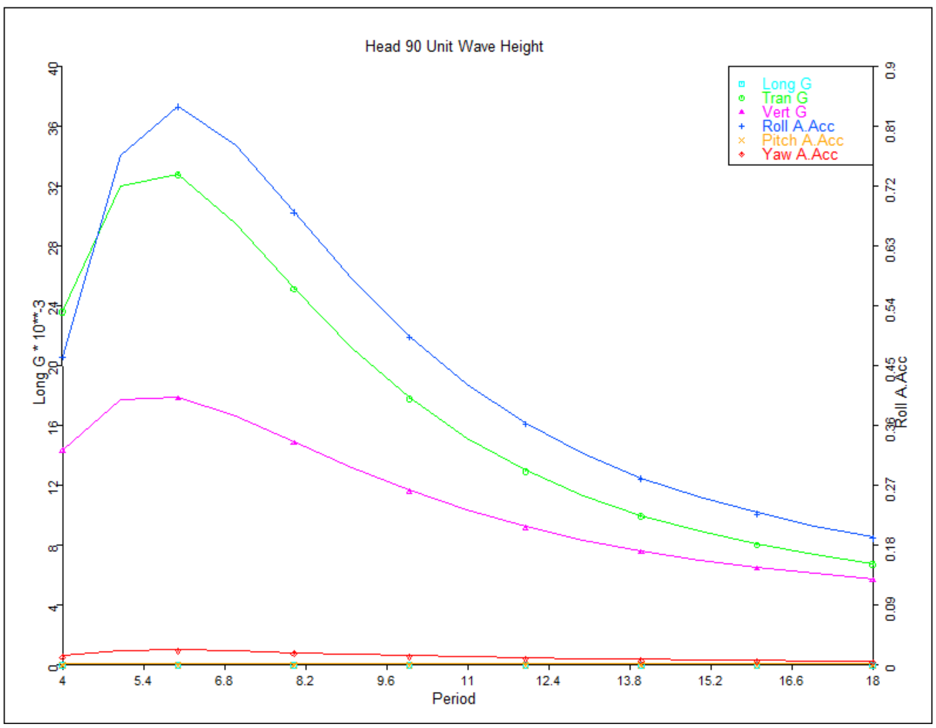


Figure 10: G Force Statistics for 90 deg Using Native Commands

After the hydrodynamics results is where our analyses diverged. In the native commands we made a still water load case, RAO load cases, then we just asked for the default combination of RAOs and environment spectra for the spectral load cases. The report ALLOWABLE STRESS MODIFIERS shows the allowable stress modifiers for the load cases. In the native command method we did not change it so the 10 load cases were left with a modifier of 1.00. The corresponding table for the intallation tools results is found on page 57. Here the table shows 24 load cases for the tiedown members with an allowable stress modifier of 1.33. Page 62 shows the loadcases for the dynamic (jacket, can, tiedown system) analysis.

The load case names used in the installation tools is explained in the file doc00001.txt. For the installation tools more sorting and combining is done. If you open the doc00001.txt file you should be able to find the following explination of the structural load cases.

> For the structural analysis, the barge was assumed to be rigid, and the behavior of the structure was considered under the action of 282 basic load cases. The structure will be checked for the enviroments:
>
> | Case | Mean Period, | Sec. |
> |---|---|---|
> | H | 5.0 | 10.00 |
> | S | 4.0 | 11.00 |
> | V | 6.0 | 12.00 |
>
> The each of the above environments are used with the RAO load cases to produce spectral cases. These were obtained by first integrating the product of a member load RAO squared times the spectrum, then multiplying by a probability factor to obtain the dynamic stress. Here, the probability of the average of the 1/1000th highest values was used to compute the dynamic stress. These dynamic stresses are combined with the static stresses to get two load cases for each spectrum and direction. These were named LXXXAS and LXXXAC. Here, the naming convention is that the "L" in the name is the letter corresponding to the spectrum defined above, "XXX" is the direction and "A" is a process designator. The cases ending with "S" are the "normal" ones; they are the wind cases plus the dynamic deviation times the sign of the mean. This governs most members. In some cases, however, the mean of the member may be slightly in tension and the compression cases will govern. Thus, the "C" cases are the S cases minus twice the dynamic deviation.
>
> To check uplift, an additional spectral condition was used, LXXXAU. These are the mean plus the dynamic deviation.
>
> A sequential structural solution was performed. First the system without tiedowns was solved for the still water case (loadouta) and then the system with tiedowns included was solved for the other load cases. The still water load case was combined with the other cases in the post processor so that the effect of the tiedowns is felt only under dynamic loads.
>
> A separate section of the program output is dedicated to the tiedowns.
>
> Here, beam internal loads and code checks for only the tiedowns are shown. Here the beam loads have been condensed into an envelope. In other words, each value presented is the maximum over all load cases. The

load cases used for checking the tiedowns are simply the dynamic loads multiplied by two. This assumes that no tension connection is developed between the tiedown brace and the barge deck, and that the tiedowns are arranged as inboard/outboard pairs. In this manner, tension that would have been developed in the tiedowns on one side of a support is added to the compression in the tiedowns on the opposite side.

Vertical support was provided by support cans attached between the cargo and the barge deck. These supports were modeled as beams, and their loads are shown in the accompanying MOSES output, in reports titled "BEAM LOADS" and "BEAM ENVELOPE". The first of these gives the still water loads and the second gives the minimum and maximum over all load cases. Since these are beam loads, the vertical support load is the axial load in the beam, and follows the standard convention where tension is positive. Therefore, any positive axial loads indicate uplift in the support.

As you can see the installation macros made special load cases to keep track of the load signs in this manner we can ensure that any wave loads would increase the axial, shear, and bending moment of a member not decrease it. We did not take this precaution in the native commands files. When you compare the results of the structural code checks you will see that the results are different. You will also notice that the installation macros have taken the extra effort to take the tiedowns out of the section where the still water case is reported. In our native command file the tiedowns are reported as part of the still water case as having 0 loads.

When you look at the graphical representation of the sturcutral results you will also see different colors. In the installation tools results the vertical members fail, this is in comparison to the native command where the vertical members pass.

We tried to make the installation tools easy to use. The purpose of this exercise is to show a comparison. A secondary purpose is to show the workings of the installation tools and show that the installation tools provide a rigerous method. You are welcome to use which ever method you prefer for your projects.

Exercise A

- Start with the deck from test files sac2 (see /ultra/hdesk/runs/tests/convert directory).
- Convert this file and transport the resulting deck on the Tidmar 251 (tdmar251.dat file).
- Take out the tiedowns that are translated with the model (elements with class T/D)
- Put the trailing nodes *J3304 and *J3303 at 100 ft from the bow.
- Put the bottome of the legs 5 ft above the barge deck.
- Use tubulars of OD 48 in ID 1.375 in for the cans.
- Use tubulars of OD 36 in ID 1.375 in for the tiedowns.

- Use the nodes *j3107, *j3108, *j3104, and *j3103 for tiedown connections at the deck.
- The tiedowns should go to the barge deck and shell intersection.
- The tiedowns should span 11 ft longitudinally between the deck point and the barge touch down point.
- Use the same env.dat for the fatigue data.
- The barge is to have adraft of 8 ft with a trim 0.57.
- Use the same winds and sea spectra.

The suggested cif and data files for this exercise are found in directory /ultra/hdesk/runs/samples/ins files tow_exer.cif, tow_exer.dat. The translated deck file is in the directory /ultra/hdesk/runs/samples/data file wk_dk.dat.

3.3 Sidelift

Topics:

- Tip–hook assembly definition
- Frequency domain analysis of motions
- Time domain analysis of motions
- Reporting relative distance between two points
- Structural analysis of suspended jacket

Reference files: /ultra/hdesk/runs/samples/how_to/sidelift.cif, sidelift.dat

Overview Discussion

This set of files show how to perform a sidelift motions and structural analysis with 'native' MOSES commands. There is a boom/hook/sling assembly defined to connect the two bodies, barge and jacket. The jacket is held just above the water.

The two body system is first put in static equilibrium, then the dynamic analysis is performed in both the frequency and time domains.

Many of the steps shown are not necessary to perform the analysis. Here we use them to show the many options the user has to check the status of the system and evaluate the configuration. The discussion assumes that the reader has the command, data, log, and output file available.

For this exercise, we will:

- Check the motions of the barge and jacket
- Check the jacket for slamming events
- Check the tensions in the boom line and slings. We will assume that the crane capacity is 1000 kips.
- Perform a structural analysis of the jacket at event 5 and the 2nd slam occurrence

Sidelift Data File Discussion

Many of the commands in this file will be familiar to the person that has worked all the exercises to this point. For the most part, this file is going to be discussed in general terms, with some discussion on the new commands. If there is a command that is unfamiliar please review the earlier exercises or refer to the reference manual.

Data that we will need for the discussion of the command file is the general dimensions of both bodies. The barge general dimensions are: length = 500 ft, breadth = 170 ft, and depth = 50 ft. The general dimensions of the jacket are: bottom elevation width = 96 ft, top elevation width = 45 ft, and height (from bottom elevation to top elevation) 201 ft.

The top section of this data file has an extra body that is not used for the analysis but is used for visual guides. This extra body is named ZZZGLOBAXES. For right now we are just going to acknowledge that it exists, we will talk about it later.

Next the barge is defined. First the outer shell is defined; then a crane (using structural elements), and finally some points of interest and a selector.

The last section is the jacket model. This is the same jacket model used in the up_lower sample. Many of the commands used to make the model have been discussed earlier. The last two lines also designate points of interest, this time for the jacket body.

Once the bodies are completely defined, we can begin setting up the analysis.

Sidelift Command File Discussion - Connecting the Two Bodies

The command file starts with the familiar commands that start a command file. The dimensions are set and the model in the data file is read. The command file itself is heavily commented. The discussion here is intended to complement the comments already in the file.

There is a comment section in the command file that reads "REORIENT JACKET". This section in the command file is longer than it needs to be. It is this long so that we can show the reorientation. Lines 25 - 31 and lines 57 - 63 are basically the same commands. We are asking for the location of the points in the part system and in the global system. Lines 25 - 31 report before the reorientation and line 57 - 63 report after. When you review the log file you will notice that the values do also change. The difference after the orientation is also tabulated in the output file. The table is the result of the commands

```
&rep_select --body jacket
&summary
    point_sum coordinate
end
&rep_select -selall
```

The first new command resets the coordinate system for the jacket part. This is done with command

```
&describe part jacket -move 0 0 0 *j0501 *j1001 *j0503 *j1003
```

If you read the manual page on the command *&describe part*, you will see that the point order is important for this command. Here was have PT1 (*j0501), PT2 (*j1001), PT3 (*j0503), PT4 (*j1003). The new part x axis will be from the mid point connecting PT4 and PT2 to the mid point connecting PT3 and PT1. The part z axis is defined by the cross product of the new part x–axis with the vector connecting PT4 to PT2. Finally the new part y axis is defined by the new x part axis and the new z part axis and the right hand rule. Resetting the part axis for a part with the same name as the body also resets the body axis. Now that we have rest the part and body coordinate system the reports that read "Reported in the Jacket Body System" will use this new coordinate system.

We are going to keep refering to joint *J1001 to keep track of the jacket. It would be a more complete analysis if we kept track of the whole lower plane. This however is an example and we are not going to present that level of detail.

For the points we have designated the jacket part xy–plane has the face nearest the water. The origin is at the midpoint of the vector between *j1003 and *j1001. The x axis is from the origin toward the top (towards midpoint of *j0503 and *j0501). The part z axis is vertical and the y axis is generated from the right hand rule.

The location of these points on the jacket model can be seen in Figure 11. The commands used to generate this view are shown below the figure.

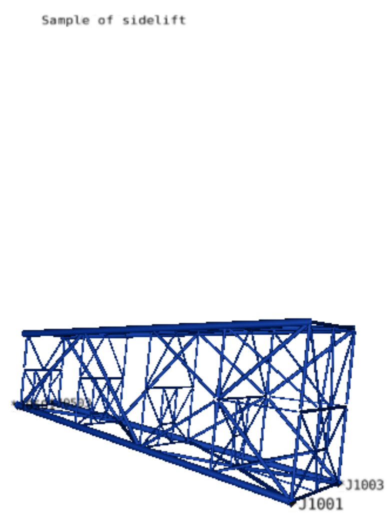


Figure 11: Iso view of points used to redefine the part coordinate system

```
&select :ppp -select *j0501 *j1001 *j0503 *j1003
&picture -90 -25 0 -render gl -water no \
                -body jacket -points :ppp -anotate points
```

After reorienting the jacket, the next set of commands locate the bodies relative to each other. When locating the jacket, keep in mind that we are now using the new jacket origin and coordinate system. The *&instate* command is written on two lines, however with the line continuation character "\" it is all one command. The barge is set at a 20 foot draft but its bow centerline is kept at the global X-Y origin. The jacket origin is set 143 ft in the positive global x-axis (143 ft aft of the barge bow); 200 ft on the positive global y axis (200 ft starboard of the barge centerline); and, finally, the origin (the midpoint of the vector between nodes *j1003 and *j1001) will be 1 foot above the water level with a –9 degree pitch (the top elevation will be pointing up).

Now that the bodies are positioned, we can define the connectors. The connectors are added in the model editing menu which is entered with the command *medit*.

First we define the classes. We will need classes for the boom line, the slings, and the hold–back lines (tuggers). We define the classes ˜boom and ˜sling as having an outer diameter of 3 inches and a length of 200 ft; and the class *˜airt* to simulate the hold–back lines. In this case we will simulate the hold–back lines with a a small tug boat, but, for this analysis we will refer to it as an air tugger.

In the next set of commands two air tugger connectors are defined as connecting to the jacket top at point *j0501. The values used in the *–tug* option indicate direction and length. Essentially the combination of tugs are going to act in the 45 degree direction.

The next set of command define the tip–hook assembly. The tip-hook assembly consists of a boom line and four slings. First, we attach one end of the boom line to the boom tip and one end of each sling to the appropriate point on the jacket. This is what is done with the five *connector* commands defining boom, sling1, sling2, sling3, and sling4. Now attach all 5 segments to a common hook. This is much like attaching the hook hanging from the boom to the four slings attached to the jacket. The attachment of the 5 segments is done with the *assembly t–h_definition* command.

At the end of the *assembly t-h_definition* command there is the option *-initial*. From the manual we learn that using this option instructs MOSES to move the body so that the hook point is directly below the boom point. So far, we have not checked the geometry to verify the designated sling lengths will work with the position of the bodies. For now the *–initial* option only places the hook below the boom, we are not expecting the slings to be tensioned or slack.

Now that our connectors are defined, we can exit the model edit menu and complete the analysis setup. To exit the model edit menu, we issue the *end* command.

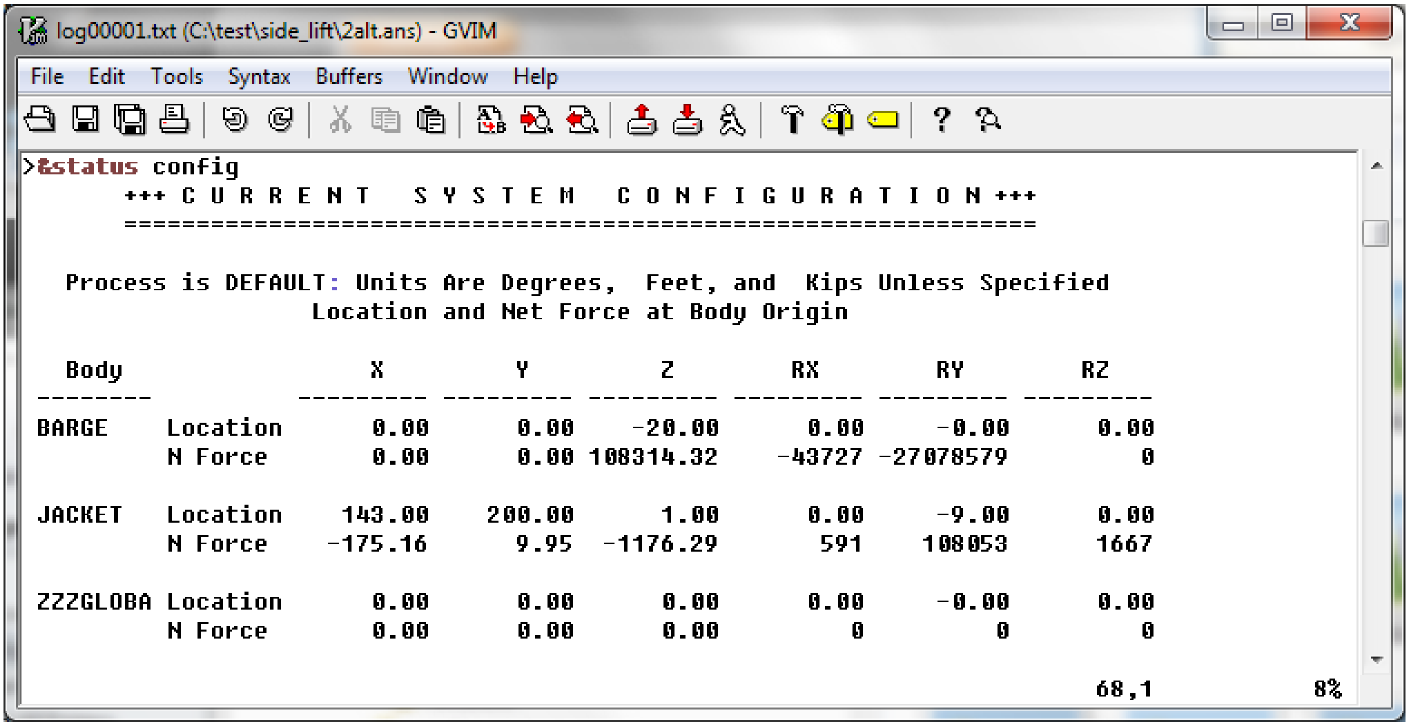
Sidelift Command File Discussion - Connecting the Two Bodies

Now that we are back in the Main Menu our objective to set the system in static equilibrium in preparation for the dynamic analyses. The first thing we want to do in the main menu is check the configuration. We do this with a series of *&status* commands.

```
&status config
```

```
&status cl_flex
&status g_connector
&status tip-hook
&status b_w
```

The results of these commands are shown in the log file. The config report (Figure 12) will show us the position and any forces in each body. When you first review the resulting table you will notice that the body ZZZGLOBAXES is listed and that all the values are zero. Since we are interested in the values associated with barge and jacket, we can see from the results that the resultant forces and moments (N Force) are actually quite large. Our system is not in equilibrium.




```
>&status config
      +++ C U R R E N T   S Y S T E M   C O N F I G U R A T I O N +++
      ================================================================

   Process is DEFAULT: Units Are Degrees,  Feet, and  Kips Unless Specified
                     Location and Net Force at Body Origin

   Body                   X         Y         Z        RX        RY        RZ
 --------          --------- --------- --------- --------- --------- ---------
 BARGE    Location      0.00      0.00    -20.00      0.00     -0.00      0.00
          N Force       0.00      0.00 108314.32    -43727 -27078579         0

 JACKET   Location    143.00    200.00      1.00      0.00     -9.00      0.00
          N Force    -175.16      9.95  -1176.29       591    108053      1667

 ZZZGLOBA Location      0.00      0.00      0.00      0.00     -0.00      0.00
          N Force       0.00      0.00      0.00         0         0         0

                                                                68,1          8%
```

Figure 12: Results of *&status config* command

The next three reports (*cl_flex*, *g_connector*, *tip-hook*) show details of the connector classes, connector geometry, and sling assembly geometry, respectively.

It is also a good idea to review the buoyancy and weight report. This is what is presented with the results of the *&status b_w* command. This report shows the weights, buoyancies, and their centers. From the results of *&status b_w* we learn that the jacket weight is 1190 kips.

We are going to continue the search for static equilibrium and we will continue to produce these tables until we are satisfied all the results can be explained.

In the next command, *&connector &boom –l_tension 1000* we change the boom length until the tension is 1000 kips. This is the maximum capacity of the crane. Right after changing the boom line length we ask for a report of the forces in the connectors, *&status f_connector*. This shows us that indeed, now the force in the boom sling is 1000 kips.

However, the vertical force in the slings sums to 988 kips (310.7+310.7+183.3+183.3). Also, the *&status configuration* table shows the jacket to be 188 kips out of equilibrium, which we know the slings were not holding.

So what's up? Notice that the forces are reported in the body coordinate system. Since the jacket has a 9 degree pitch, Z_body is NOT parallel to Z_global. If we do the math, the force of the jacket in the global z direction is 1190.63 * cos(9deg) = 1176.02 kips. This is where the 188 kips net force comes from.

With the command *&status tip-hook* we see what change was done to the boom length. Originally the boom length was defined as 200 ft, we see from the report that the length has now been changed to 221 ft. This change resulted from the *&connector &boom –l_tension* command.

Now that the slings and boom line are set up, we need to make sure the barge is in equilibrium. If we had compartments modeled, we could change our ballast configuration. However, since we don't, we can add a weight. In the next command, *&weight –compute* we change the mass properties of the barge so that it is in equilibrium in the current state. The current state includes the lightship weight and CG location, the buoyancy force, and the force from the boom. After this command, the report from *&status config* shows that the body barge is in equilibrium.

To verify that the sling assembly has not changed we again report the forces in the connectors with *&status f_connector*. We also ask for a report of the position of joint *J1001 to make sure the jacket is out of the water.

At this point we know that the body barge is in equilibrium but the body jacket is not. We are going to let MOSES change the location (translation, and rotation) in our next attempt at finding equilibrium. Before we do that we need to turn off the airtuggers. In the command file we do this with two command lines. It could be done with one. This way we get to see how to make selector with the wild character (@).

First we make a selector *:air* with the command *&select :air –select airt@*. This will create a set of items that begin with airt. The command *&connector :air –inactive* turns off (*inactivate*) the airtuggers. This way when we ask MOSES to find equilibrium for the jacket only the sling forces, the weight, and buoyancy of the jacket are used.

Previously, we ensured that the barge is in equilibrium. Now, we want to exclude the barge from any changes when the jacket is being altered for equilibrium. The *&describe body barge –ignore x y z rx ry rz* tells MOSES to ignore the barge when calculating equilibrium.

The command *&equi* will change the position (and orientation) of jacket with the objective to find equilibrium. This command makes 50 attempts at finding equilibrium. If equilibrium is not found within tolerance it will report a WARNING message. At the conclusion of the equilibrium calculations, the command *&status configuration* produces a report which shows that the jacket body is in equilibrium, but the barge body now is not in equilibrium. We also see that the vertical position of the jacket has changed, moving the jacket into the water. Since part of the jacket is in the water, the tension in the slings changes, which in turn causes a change in tension in the boom line. Therefore, the results of the *&weight –compute* which were based on a boom tension of 1000 kips are no longer valid. Now we see that the barge is out of equilibrium by nearly 188 kips.

Since we are trying to analyze the case where the jacket is in the air, we need to check to verify the jacket is above the water. We can verify this by checking the location of one of the jacket corners, specifically the location of *J1001. To make this check we use the string function *&point(coordinate *j1001 –g)*. String functions actually query the database and return the values asked. We need to ensure that we are telling MOSES what to do with the return values. In this case, the command *&type location of *j1001 = &point(coordinate *j1001 –g)* tells MOSES to put the results in the log file which shows "location of *j1001 = 155.8654 248.6527 -4.199845" We can see from the coordinates of *j1001 that the jacket is not completely out of the water.

In order to analyze the case with the jacket above water, we are going to again change the length of the boom sling. This is done with the *&connector &boom –l_delta* command. The boom sling will be shortened by 8 feet. This should lift the jacket from the current –4 feet to a +4ft.

First we check that the boom sling has been changed by 8 ft. Earlier the command *&status tip-hook* reported 221.93 ft for the boom line length. We see that now after the change it is 213.93 ft. Next we check the tensions on the slings with *&status f_connector* and find that the sling tensions are very large. This is a result of the boom sling being shortened but the position of the jacket not moving to accommodate the shortened length. The solution is to use *&equi* again, so that MOSES can reposition the jacket.

The results of *&equi* show that the jacket has been moved and that the barge is still out of equilibrium, by the same 189 kips. Next we will check the position with the same string function *&point(coordinate *j1001 –g)* that we did before. We see the results now show that the position of joint *j1001 is not 4 foot above the water line, as expected, it is 1 foot above the water line. The reason for this discrepancy is that when the jacket was moved (with the *&equi* command), it was moved in all 6 degrees of freedom. In our previous results of *&equi* the jacket pitch was –11.94 degrees and now it is –13.62 degrees. Now that we have resolved the pitch question we can conclude the jacket is above water as desired.

Now we will deal with the barge out of equilibrium issue. For this we bring back the barge into the calculations. To take the barge out of the calculations we used the command *&describe body barge –ignore x y z rx ry rz* to bring the barge back into the calculations we use the command *&describe body barge –ignore*. When the option *-ignore* is used and the space after it is left blank it turns on all the degrees of freedom for that body.

The results of the next *&equi* command show that both the barge and the jacket are now in equilibrium. Note that now the barge has a list to starboard (RX = –0.17

deg), and the jacket has a list toward port. The same report is repeated with the *&status config* command. As before we also review the results from the *&status b_w* command. The results in these reports will not include the force of the connectors (slings). We are NOT expecting the buoyancy force to equal the weight.

And finally we activate the airtuggers with the command *&connector :air –active*. Once we have activated the airtuggers we review the forces on the connectors again, and find the force in the boom line is 1184 kips. Since our crane capacity is 1000 kips, we are going need a larger crane barge. However, for the current lesson, we will assume the crane is capable of handling the loads.

Before ending the static analysis section we plot some pictures. The three commands that begin with *&picture* will save the views: starboard, bow, and top. Now we get to talk about the body ZZZGLOBAXES. In the starboard view of the system you will see thick green arrows which represent the X and Z axes. From the top view you will see the X and Y axes. So the body ZZZGLOBAXES acts as a visual reminder of the global system.

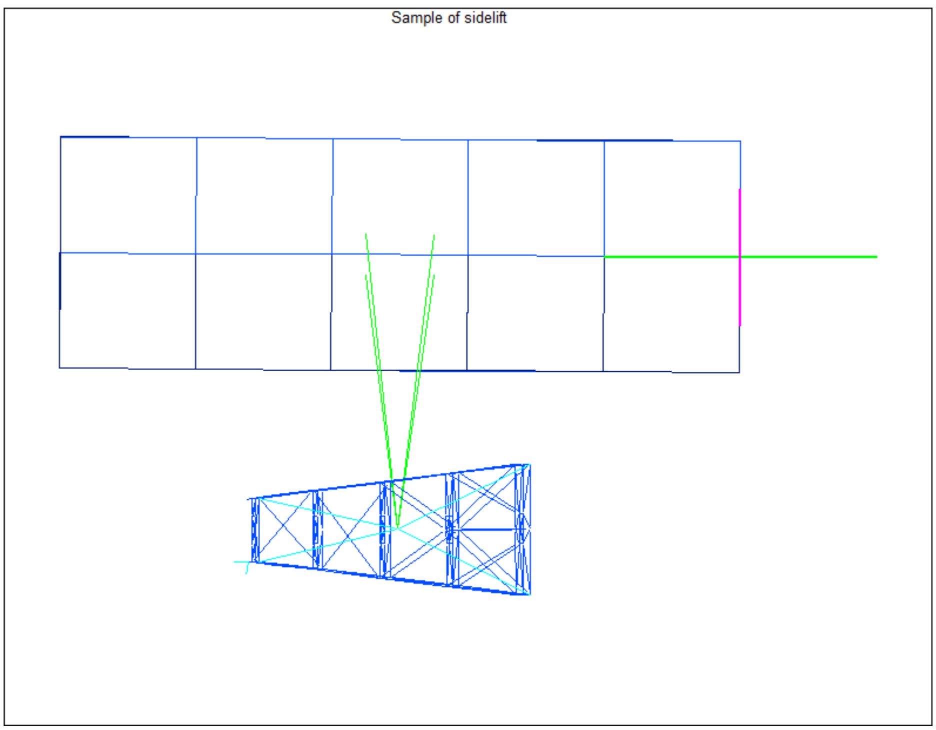


Figure 13: Top view of configuration with global X and Y axes

And having those three views, we finish the static analysis portion of the command file.

Sidelift Command File Discussion - Dynamic Frequency Domain Analysis

The dynamic analysis portion of the command file begins with the command *hydrodynamics*. This command enters the Hydrodynamics menu where the hydrodynamic database will be computed.

The database is a description of the panel pressures below the water surface. To generate the pressure database we issue the command *g_pressure*. There are many options that can be used with *g_pressure* but we are using the bare minimum to complete a dynamic analysis. We specify one environment heading and a very small number of periods. If this were a real world project both of these lists would be longer. The periods would not be evenly spread, instead, they would have a concentration around the peak period, with an over all spread to cover the energy of the expected wave spectrum.

In the log file after the *g_pressure* command we see a very short report of what MOSES is doing. We see that strip theory was used to make the calculations and that only 90 panels were used. Depending on the shape and size of the vessel we might be interested in 3d diffraction and increasing the number of panels. Since this is an exercise, we are not going to do a study to determine the best number of panels and the best hydrodynamic theory for our problem.

Now that we have a hydrodynamic database we exit the hydrodynamic menu using *end*. Now we can compute motions and forces. First we will perform a frequency domain analysis, this is also known as a linear analysis. All of the frequency domain analysis is done within the Frequency Response menu which is entered with the *freq_response* command. After we are finished with the frequency analysis we will exit the Frequency Response menu with the command *end*.

You have to be careful about using the command *end*. This command is used to exit many of the menus. Within the Frequency Response menu we will enter the Disposition menu. We need to make sure we keep track of the use of *end* so that we do not accidentally exit into a menu and then have to re-enter the one just exited.

With in the Frequency Response menu the **FIRST** thing we do is calculate the response amplitude operators. This is simply done with the command *RAO*. This command computes the RAO but does not report them. Here MOSES will compute the RAOs at the body origin.

Once the RAOs are computed for each body, we have to tell MOSES which body we are interested in before we ask for the report of the motion RAO. This is why there is an *&describe body bname* before each of the *fr_point* commands. The log file shows that for each body the RAOs were reported at the local x = 0, y = 0, and z = 0 location (the body origin). Since these are the default values we are just showing the command order to report the different RAOs, we are not trying to fully scrutinize the response. The command *fr_point* makes any necessary final calculations to translate the motion RAOs to the point specified.

Notice that after each *fr_point* command, you are placed in the Disposition menu. Within the Disposition menu the command *report* generates the standard motions RAO report and puts it in the output file. In the out file, you have two reports titled

```
"M O T I O N   R E S P O N S E   O P E R A T O R S"
```

The third line of each report reads

"Of Point On Body {body name} At X = 0 Y = 0 Z = 0"

where {body name} is either BARGE or JACKET. The reports show the calculated values for the RAO of each degree of freedom. These values include both amplitude and phase. When we review the results of *fr_point* we see that the peak response of the barge for sway and heave occurs at 11 seconds, while the peak response for roll and pitch occurs at 8 seconds. The peak response of the jacket for sway occurs at 9 seconds while the peak response for heave and roll occurs at 8 seconds.

The report of the JACKET RAOs are really response amplitude operators, they are not the results of hydrodnamics on the jacket. The JACKET is being forced via the motion of the tip hook and sling connectors.

For now that is all we are interested in, so we exit the Disposition menu with the command *end*, which puts us back in the Frequency Response menu.

We next report the motions of the point designated in the *fr_point* command. We do this with the command *st_point –sea issc 90 10 4 –e_period 5 6 7 8 9* followed by *report motion*. This command calculates the statistics of the body motions for a sea with an ISSC distribution, in the 90 degree heading to the vessel, with a 10 ft significant wave height, and a 4 second mean period. The option *–e_period* instructs MOSES to consider the additional mean periods listed. Again, we are placed in the Disposition menu where we tell MOSES to report the motion statistics (*report motion*) and exit the Disposition menu (*end*).

In the out file, we can review the results of *st_point*. Here we have a report titled

"M O T I O N   S T A T I S T I C S"

Here the third line of each report reads:

"Maximum Responses Based on a Multiplier of 3.720"

This tells us on what statistic the maximum values are based. In this case, the maxima have a multiplier of 3.72 which corresponds to $A_{1/1000}$. The multiplier for other values can be readily derived from the derivation of the Rayleigh distribution. They are also shown in the document "HOW MOSES DEALS WITH TECHNICAL ISSUES" which is included in the MOSES distribution (hdesk/documents/deals.pdf).

We see that motions for the barge increase as the wave period increases. For the jacket, however, we see the motions are mixed. For sway the largest motion is 9 seconds, but for heave and roll the largest response is around 6 seconds. What catches our attention is that the maximum dynamic response in sway is 69 ft. If you recall the beam of the barge is 170 ft, the bottom elevation of the jacket is 96 ft. The jacket origin was placed 200 ft starboard of the barge centerline. This leaves 69 ft of clearance. The report we are reading tells us that there is the possiblity of collision.

Following the motion reports, we next report the forces in the connectors. The connectors do not belong to a body so it does not matter if the last *&describe body* command was for jacket or for barge. First we get the frequency response for the sling labeled sling1 (*fr_cforce sling1*) then we get the frequency response for the boom sling (*fr_cforce boom*).

In the last set of commands we ask for the statistics of the connector forces in the defined sea state. This is done in the command *st_cforce @ –sea issc 90 10 4 –e_period 5 6 7 8 9*. Like the motions, this calculates the statistics of the connector forces for a sea with ISSC distribution, in the 90 degree heading to the vessel, with a 10 ft significant wave height. The mean periods of the distribution that will be considered are those listed from 4 to 9.

When we review the results of *fr_cforce* we see that the peak response occurs at 8 seconds. This is in the out file, the tables titled "Connector Force Response Operators" This means that a wave with mean period of 8 seconds will reinforce the response. By reviewing the connector force statistics, the results of *st_cforce* we see that indeed the highest force are reported around the 8 second period. These results are in the out file in the report titled

```
"C O N N E C T O R   F O R C E   S T A T I S T I C S"
```

We want to review the statistics of the forces because during any operation the wave properties will change. It is best to get the reactions to a set of expected waves. This also helps us check if there are concerns with a change in the frequency of the waves during the operation.

Reviewing the manual you will find that there are several command that start with *fr_* and *st_*. The *fr_* indicates the frequency response will be calculated. The *st_* indicates the statistics based on the frequency response will be calculated.

This conclude the frequency domain section of the command file. Next we will look at a time domain analysis.

Sidelift Command File Discussion - Dynamic Time Domain Analysis

In the frequency domain analysis, we could define the wave spectrum as part of the statistics command. For the time domain analysis we must define the environment with the *&env* command. The format used is the same in *&env* and the option *st_cforce –sea*. We see that the spectrum with an 8 second mean period wave is what will be used in the time domain analysis. The option *–time 100 0.2* tells MOSES that the time domain analysis will look at 100 seconds at 0.2 second intervals. The time interval chosen here is usually considered rather large, but since this analysis is just an example, these values will not take long to compute.

The time domain analysis is performed with the command *tdom*. You will see in the log file the message "Time To Set Up Convolutions" then MOSES reports when it saves the database and where it is in the event sequence. The last message "Simulation Terminated at Specified Time" tells us that the time domain analysis computations are finished. Note that MOSES has performed the calculations for the time domain analysis and stopped. Reporting the results will occur later in the analysis.

In the next three commands we find when a slam occurred during the first 50 seconds. As an input to the *&slam* string command, we need to know the name(s) of the parts that we want slam information. For our analysis, this just happens to be the one part "jacket". We made a selector here to show how selectors are used. The next line

```
&type SLAM 1 to 50 seconds .2 sec increments
```

leaves a note in the log file to remind us of the start time, finish time, and time step. The final line

```
&type  SLAM = &slam(:lower 1 50  .2)
```

types into the log file the results of the string command *&slam*. This will leave a note and when we review the log file we see that slam events occurred at times 0, 20.2, 23.2, 28.2, 31.4, 36.8, 41.6, and 47.6. Now the question you are probably asking is, "Why is time 0 in the list?" If we read the manual

www.ultramarine.com/hdesk/ref_man/timdom.htm

we see that the list is a set of pairs where some element of the selected part(s) is submerged between e1 and e2. The result is the list of pairs where the part enters and exits the water. The value 0 is part of the first pair, therefore it gets reported.

Now we get back to the project requirements; for the structural analysis, we are to use the forces at event 5 and the second occurrence of a slam event. We are going to interpret this as the second event reported by the *&slam* command. We want MOSES to do this automatically for us. During a project many things can change and we certainly do not want to be running a lengthy time domain analysis then half-post processing the results to get the event at the second slam and then restarting MOSES to finish post processing. Gathering the list of slam events is considered post processing, however it is done in the Main Menu. For the rest of the post processing of the the domain we will be doing it in the Post Processing menu.

This is where we can use variables and the string function *&token*. First we set the variable f_time to the string of times resulting from the *&slam* command. Then we use the *&token* command to pick the second value. At the end the variable f_time will be set to 20.2. Now we are ready for post processing.

The majority of the post processing will be done inside the "Post Processing Menu" which is entered with the command *prcpost*. What I mean by post processing is somehow getting MOSES to only display the values in the database that are interesting to the project. During the analysis many items were added to the database. To name a few - (at each time event) wave height, wave force, force on the connectors, position of each body, and velocity of each body. By post processing we are going to get MOSES to display the values the project wants to examine.

In order to compare the time domain results to the frequency domain results, we need to get the motions and the connector forces. We first get connector forces with the command *conforce*. This command puts us in the Disposition menu again. Then we ask for the list of variable names or column headings (*vlist*) that are available. In the log file we see that there are 57 values available: the events and 8 values for each connector. For now 57 values are not too much to work with. If we had needed to keep the list of variables to a more manageable size we could have made a selector to restrict the data to those in which we are interested. The format of the command would be *conforce :sname*.

From the results of *vlist* we see 1 corresponds to event number 8 corresponds to magnitude of airtugger 1 and 16 corresponds to magnitude of airtugger 2. The command which makes a plot of the three values is 'textstyleEmphasisplot 1 8 –rax 16 –t_main "Airtuggers" ...' . Now if you recall, when we defined the airtuggers we did not give them the ability to change magnitude. So our plot is going to be two straight horizontal lines.

Next, we plot the magnitude of the boom and the slings. For this plot we will definitely see some changes as the events change. Note that for both plots, the main title, subtitle, and axes labels are defined. If this is not desired (say you are doing a quick check plot), then this could be omitted and the option *-no_edit* used. The *-no_edit* option tells MOSES to use the default labels.

Once we have created the plots, we ask for the standard reports with the command *report* then exit the Disposition menu with *end*. Now we are back in the Post Processing menu.

The plot of the connector magnitudes show that the sling tensions (right hand axis) can change from 70 to 640 kips. We can compare the maximum number to the 629 kips reported via the linear analysis. Reviewing the frequency domain report headers we see that the 629 kips is mean plus maximum. We know from our static analysis that the mean value for sling1 is 339 kips. Which means that the dynamic portion is 290 kips (629 - 339 = 290). For a linear analysis the dynamic portion is added and subtracted, which results in a minimum tension for sling1 of 49 kips (339 – 290 = 49). Just comparing linear and non-linear analysis for the the maximum and minimum sling1 tension values leads us to believe a linear analysis is not too bad.

Next we compare the motion results.

We do a similar set of commands for the *trajectory* menu. We get the association of the numbers with the column headings with *vlist*. We use this information to get a plot of the barge motions then we get a plot of the jacket motions. Review of the plots shows us something that we could not see in the linear analysis. The system as defined does not have a mooring system, therefore the system wanders in the negative y direction (it is being pushed by the 90 degree waves.) The range of motion of the barge is 60 ft, the range of motion of the jacket is 150 ft. We need to look at the phasing of the two motions to see if there is a strong possibility of collision.

To monitor this we will use a variable named "bang" To begin the investigation we are going to make the assumption that a collision does not occur. So we set the value of bang to .false.

In the next set of commands we get relative motion information. This type of data was not available in the frequency response section. The command *rel_motion *ptn1 *pnt2* tells MOSES to find the motion from the first point to the second point. Here we will be using the three edge points that were designated as points of interest in the data file (*&describe interest –associate *edge/*).

Here it gets interesting because we are using a *&loop* command to cycle through the list. The first time it will use edge = edge1, the second time it will use edge = edge2, and the third time edge = edge3. On all three cycles the distance to jacket node *j1003 will be measured in the xy-plane of the barge. This means that if the barge has a slight roll the xy-plane will have that rotation, and will not be parallel to the global xy-plane. We will produce a plot of the distance to each edge point separately then we will produce a plot of the distances plotted together.

The results of *vlist* in the log file show that for each loop cycle the column (variable) names will only differ by the 1, 2, or 3 after "edge" So we can use the same column number to get the data of interest. A review of the log file shows that column 5 is always the position magnitude and column 1 is always events. Here we are using a new command *set_variable*. Up to this point we have been using the global form of the command *&set* to define variables. Here the command *set_variable* makes the association with the data that is in the disposition menu. First we are going to find the minimum distance, it does not matter when the minimum distance occurred. The command *set_variable %edge –min 5 5* finds the minimum of column 5 each time the loop cycles. For this discussion we are going to refer to these as the collision variables. So the first time through the loop cycle the collision variable is "cedge1" the second time "cedge2" and the third "cedge3" Individually these variables will be set to whatever the minimum value happens to be for that time through the cycle.

The second set of variables are "redge1" "redge2" and "redge3" These we will call the distance columns. One of these variables is filled each cycle. These variables are populated with the string of values in column 5. We will be using them when we produce the plot of the three distances together.

In getting the values for the "event" we do not need to cycle the name. The list of events is the same regardless of what point is being referenced. It is inefficient to have the same values recorded three separate times. I, however, was not willing to put in the extra keystrokes to make the variable event be filled only once. I left the commands in the sloppy form here.

Back to investigating if the two bodies collide. In setting the collision variables cedge1, cedge2, and cedge3 we were monitoring the distance on the barge xy-plane between the two bodies. If a negative distance is recorded as a minimum, then a collision has occurred. We need a way to ask MOSES if the value recorded for the collision variables is negative. One time is sufficient, we do not care if it occurs multiple times. What we are going to record, or change, is the value of "bang". Once the value of "bang" is changed to .true. we do not want it changed back to .false., and we do not care for it to be reset to .true. a second time.

First we check what the current value of "bang". If this value is **.true.**, then we do not need to change the value and can skip the checking. If the value of "bang" is **.false.**, then we will check to see if it needs to be updated.

Checking is done with the if statement *&if .not. %bang &then* and ends with the command *&endif*. Within the if statement we set the value of "bang" to the results of the *&logical* statement. The logical statement simply returns either .true. or .false. In this particular instance we are asking MOSES to see if the value of the collision variable is negative (less than 0). If the value of the collision variable is negative, then "bang" is set to **.true.** and the variable will not be changed again in the loop cycles.

Before the loop cycle completes a plot of the relative position (still working with columns 1 and 5), the distance between the two points, is made for each time through the loop. The command *&endloop* tells MOSES where the cycle returns to the top, and for the last entry (edge3) the loop cycle is exited.

We have put a great deal of effort into the collision values. We leave ourselves a note right after the loop to let us know the result. Here I am referring to the three command lines that begin with *&type*. Review of the log file shows that the values for the variables are substituted. We see from the short message that the barge and jacket did not collide. We also see from our short message that there was a minimum of 8.4 ft clearance between the two bodies. This is actually a big deviation for the 1 ft clearance we determined with the linear analysis. If this were a real project we would have probably only used the linear response menu to make sure our setup did not cause problems with the software, considered basic checks. The sling elements can go slack, making them non-linear connectors, and therefore we should only consider the results of the non-linear analysis.

In the next set of commands we are going to be using the *&buildg* menu. This is where we combine the three distance columns into one plot. Recall that we have created the variables, redge1, redge2, and redge3 as part of reporting the relative motions. These variables have been populated with the string values representing the distance between the two points at each time step. The main purpose of presenting the gathering of this data in the *&buildg* menu is to show the set of commands to put this new table together. MOSES is a programming language, and is intended to be able to analyze many different types of configurations. MOSES comes with preset formatted tables for the analyses considered common. Being able to use the *&buildg* menu is a way to gather data and further process it for the uncommon configurations.

Before entering the Build Graph menu we need to know how many rows there are going to be. We will of course let MOSES figure this out for us. Here is another instance with the use of the string command *&token(n string)* comes in handy. The string command determines how many tokens, or entries, are in the variable event and sets the variable "n" equal to that. We will use *&token* several times in the Build Graph menu, so it would be worth reviewing the format in the manual.

By this time you have probably figured out that the command *&buildg* will put us in the Build Graph menu. The command with option *&buildg –brief* here is much like the command with option *plot –no*. Here we are telling MOSES to just accept our input and not ask for verification. Since we are using the *-brief* option we are going to have to pay close attention to format. The next four lines with commands (no comment character) are the labels for the column headings.

The next line is blank. It is important that the line immediately after the last column heading is blank (the comment character is after the blank line). This is how we tell MOSES that the list of column headings has ended. As the comment in the command file reads, the next set of commands populate the table. Here we are using a loop again. We start with the first event and the value for each edge associated with that event. The table is being populated one row at a time. Each time through the loop a row is populated. When the data input has been completed (jjj = n) the loop is exited and we have another blank line. The blank line is important here also. This is how we tell MOSES that the data input has finished.

When you review the log file for this section, you will see that this section of the log file is blank. MOSES usually does not echo to the log file inside the *&loop*.

After the loop we see the results of *vlist* are as we input in the lines above. Finally we use the plot command to make the plot with all four sets of data on one plot. Then we exit the Build Graph menu with *end*.

The next command is just a message to ourselves to make sure we are in the Main menu. We will next be doing a structural analysis to satisfy the final project requirement. The only way to enter the structural solver is through the Main Menu, so we want to make sure that is where we are. Inside the structural solver, we will need to specify which restraints to include in the structural solution. Since we are only looking at the jacket structure, only the four slings attached to the jacket are required. This is why we need to set the selector :restraint to only select the slings attached to the jacket.

We enter the Structural Solver menu with the command *structural*. We tell MOSES which load cases to use with the command *lcase –process*. Remember we have set the value of f_time to the second occurrence of a slam event, and the project requirement is to have a load case at time event 5. In the next command *s_rest*, we tell MOSES which restraints to use for the structural solution. This is followed by the command *s_part* which tells MOSES on which part to perform the structural solution. If this had been a single body analysis we would not have had to be so specific with all these commands. Finally the commands *reduce* and *expand* perform the structural analysis.

Like many processes in MOSES we need to first perform the analysis, then ask MOSES to report the results. So we exit the Structural Solver menu with the command *end*.

To post-process, we enter the Structural Post-Processer menu with the command *strpost*. Once inside the Structural Post-Processor we ask for the results of the beam code check with the command *beam_post code_check* and a summary of the restraint loads with the command *restraint loads*. We see from the WS Beam Check Standard table that the loads created by event 5 dominated for many of the beams.

Exercise A

Perform statistics on the time domain connector force (boom and slings) results. Compare these to the frequency domain results.

Suggested Answer:

```
conforce
   vlist
   statistics 1 24 32 40 48 56 --hard
end
```

The statistics of the boom and slings are reported in the output file.

Remember to compare proper values. The period is 8 seconds. The frequency domain reports the mean + maximum response so that should be compared to the "Maximum" and "Minimum" values from the time domain. The output is shown below.

Frequency Domain

Period	Name	FX	FY	FZ	MX	MY	MZ	MAG.	Ten/Brk
8.00	AIRT1	17.68	-103.97	-35.32	0	0	0	111.22	11.1223
	AIRT2	27.21	13.19	-41.04	0	0	0	50.98	5.0982
	BOOM	64.34	362.43	-1414.90	0	0	0	1461.99	3.4472
	SLING1	-159.49	-272.54	487.46	0	0	0	580.80	1.3694
	SLING2	-125.66	297.68	403.66	0	0	0	517.05	1.2191
	SLING3	359.63	-237.81	344.28	0	0	0	551.74	1.3009
	SLING4	383.80	235.30	379.56	0	0	0	588.84	1.3884

Time Domain

Description	MAG BOOM	MAG SLING1	MAG SLING2	MAG SLING3	MAG SLING4
Mean	1151.32	335.45	340.27	336.33	346.28
Av Of 1/1000 Highest	1770.63	639.58	614.43	581.25	492.39
Av Of 1/1000 Lowest	379.77	73.58	77.51	126.03	150.18

We see that the magnitudes of all connectors are greater in the time domain.

Exercise B

Perform relative motions and slamming calculations/plots without loop or the &build_g menu.

Suggested Answer:

```
&set bang = .false.    $  start off assuming it does not bang
rel_motion *edge1 *j1003 *edge2 *j1003 *edge3 *j1003 -mag x y
    vlist
    set_variable cedge1 -min  5  5
    set_variable cedge2 -min 17 17
    set_variable cedge3 -min 29 29
    &set bang1 = &logical(%cedge1 .lt.  0)
    &set bang2 = &logical(%cedge2 .lt.  0)
    &set bang3 = &logical(%cedge3 .lt.  0)
    &if .not.  %bang &then
        &if %(bang1) &then
            &set bang = .true.
        &elseif %(bang2) &then
            &set bang = .true.
        &else   %(bang3) &then
            &set bang = .true.
        &endif
    &endif
$
$ plotting - individual curves
      plot 1  5 -t_sub "Relative Position" \
                -t_x     "Time (sec)"      \
                -t_left  "Distance :  *edge1 *j1003"
      plot 1 17 -t_sub "Relative Position" \
                -t_x     "Time (sec)"      \
                -t_left  "Distance :  *edge2 *j1003"
      plot 1 29 -t_sub "Relative Position" \
                -t_x     "Time (sec)"      \
                -t_left  "Distance :  *edge3 *j1003"
$
$ plotting - combined curves
      plot 1  5 17 29 -t_sub "Relative Position" \
                      -t_x     "Time (sec)"      \
                      -t_left  "Distance to *j1003" \
                      -legend 1 edg1                \
                      -legend 2 edg2                \
                      -legend 3 edg3
end
```

4 Answers

4.1 Getting Started Exercise

1	KML for 12 ft draft = 1117.07 ft, and KMT for 12 ft draft = 75.44 ft
2	Righting arm = 17.84 ft for 28 deg roll
3	At longitudinal location = 0, 400 and 200 ft
4	At longitudinal location = 0, 400 and 200 ft
NOTE	Need to review table headers to understand what is being reported

4.2 Basic Stability Exercise

BSTAB

1	379.30 ft
2	78.13 ft
3	Command 'RARM 2.5 10' was used
4	The dat file is not echoed in the out00001.txt file

WCOMP

1	938.1 kips
2	5P and 5S
3	30.10

Exercise

1	Trans = 170 ft^4 Long = 227 ft^4
2	Area ratio = 5.31

4.3 Free Surface Correction Exercise

1. 0.31 m^2

4.4 Stability Check and KG Allow

1. Passes
2. Passes
3. For Draft 6, Allowable KG is 14.13, Area Ratio, Yaw = 0, damage none! Controls

4.5 Review Working with Compartments

1. Passes
2. Passes
3. 2644.61 Kips
4. 4.17 feet

5. 5s, 5p
6. 5s, 5p and 5c
7. 3c

4.6 Dynamic Flooding

Exercise A

1. 9 - RY:TBRG
2. x-axis, Event
3. left axis, Z:TBRG
4. right axis, RY:TBRG
5. plot 1 4 -rax 3 -no

Exercise B

1. Simulation Terminated Due to Capsizing has changed to Simulation Terminated at Specified Time
2. out0001 column Intern. Fl. Head and Vlv Diff Head is blank for the one with total time 1200 sec column Intern. Fl. Head and Vlv Diff Head is full for the one with total time 200 sec

Exercise C The command line before *tdom* should now read

1. &compartment -correct two -percent two 0 -dynam two

4.7 Basic Frequency Domain

Exercise B

1. Yes, the righting arm and wind arm have changed. Before the changes the righting arm crossed zero the second time after 67 degrees. After the change the second zero crossing is around 54 deg.
2. Yes, the draft and pitch changed. The draft is now deeper and the pitch is less.

4.8 Modeling Cargo Exercise

Exercise A

1. 0.901
2. 800.57 kips

Exercise B

1. Fails
2. minimum GM
3. 2037 KN
4. 68.99 KN

Exercise C
The answers for these questions may differ from those presented here. The answers are dependent on the ballast arrangement. These answers were determined with the ballast arrangement:

Name	% Full
4P	96.13
4S	73.5
5C	53.4
5P	100
5S	64.82

Answers

1. 6.90 KN
2. 4.11 KN
3. Yes
4. 16796KN
5. 0.072
6. 0.165
7. 0.299

4.9 Translating from SACS Exercise

Exercise A

1. 215. kN
2. x = 0 m, y = -13.79 m, z = -45.91 m
3. 48328 kN

Exercise B

1. x = 11.26 ft, y = -130.13 ft, z = -13.10 ft
2. 1553 kips

4.10 Longitudinal Strength Exercise

Exercise A
The command *&equi* moves all six degrees of freedom. The command *equi_h* move only z, rx, and ry.
Exercise B
The shear force and bending moment have small changes compared to the original results.
Exercise C
63.32 kips/ft
Exercise D
The shear force and bending moment from weight distribution in exercise C more closely resembles that in the original set up using *&weight -compute*.

4.11 Modeling a Fender

Copy the fender.cif command to another root name, for this exercise I will use f_exer.cif. Insert the line *&device -auxin fender.dat* before the *inmodel* command so that you can use the same data file fender.dat.
Change the *&instate -locate* command for the barge to the following
-LOCATE barge 171 29.35 -4.3 0 0 90
Change the attachements for the tanker body to the following locations.
*fent1 161 29.35 21.95
*fent2 166 29.35 21.95
*fent3 176 29.35 21.95
*fent4 181 29.35 21.95
Change the attachment for the barge body to the following locations.
*fenb1 0 10 4.3
*fenb2 0 5 4.3
*fenb3 0 -5 4.3
*fenb4 00 -10 4.3
Change the attachment point order and change the euler angle for the connectors.
connector f1 fend *fenb1 *fent1 -euler 0 0 180
connector f2 fend *fenb2 *fent2 -euler 0 0 180
connector f3 fend *fenb3 *fent3 -euler 0 0 180
connector f4 fend *fenb4 *fent4 -euler 0 0 180