Nato Pontoon with partially filled tanks

Reference data

Nato pontoon with following

Geometry

```
CREATE HULL
Comp pnt1.c
Loc @    0   = 0.05,0.64 2.05,0.64 2.05,0.74 0.05,0.74 0.05,0.64
kLoc @ -0.97  = 0.05,0    2.05,0.0  2.05,0.74 0.05,0.74 0.05,0
Loc @ -4.67  = 0.05,0    2.05,0.0  2.05,0.74 0.05,0.74 0.05,0
spacing .05
Comp pnt2.c
Loc @ -4.77  = 0.05,0    2.05,0.0  2.05,0.74 0.05,0.74 0.05,0
Loc @ -8.87  = 0.05,0    2.05,0.0  2.05,0.74 0.05,0.74 0.05,0
spacing .1
Comp pnt3.c
Loc @  -8.97 = 0.05,0    2.05,0.0  2.05,0.74 0.05,0.74 0.05,0
kLoc @ -12.67 = 0.05,0    2.05,0.0  2.05,0.74 0.05,0.74 0.05,0
Loc @ -13.59 = 0.05,0.64 2.05,0.64 2.05,0.74 0.05,0.74 0.05,0.64
spacing .05
/
```

Ballast plan

Tank WBT1.S is filled for 50% with fresh water Tank WBT1.P is filled for 10% with fresh water

Loads and weight

Model creation

The hull shape and tank shapes were created in Blender and exported as .obj. The source .blend files are located in this folder.

See [https://www.open-ocean.org/meshing-with-blender/ (https://www.open-ocean.org/meshing-with-blender/)](https://www.open-ocean.org/meshing-with-blender/) for some tips and tricks on working with Blender

In [1]:
```
from DAVE import *
from DAVE.jupyter import *
```

```
Equilibrium-core version = 1.03
default resource folders:
C:\Users\beneden\Miniconda3\envs\DAVE\lib\site-packages\DAVE\resource
s
C:\Users\beneden\DAVE_models
Blender found at: C:\Program Files\Blender Foundation\Blender 2.83\bl
ender.exe
embedWindow(verbose=True): could not load k3d module, try:
> pip install k3d      # and if necessary:
> conda install nodejs
```

In [2]:
```
from DAVE.gui import *
```

In [3]:
```
s = Scene()

s.new_rigidbody('Nato Ponton')
s['Nato Ponton'].mass = 7.5
s['Nato Ponton'].cog = (6.82, 0.0, 0.38)

# Load geometry
s.new_buoyancy('Buoyancy mesh', parent = 'Nato Ponton')
s['Buoyancy mesh'].trimesh.load_obj(r'Nato ponton.obj')
s['Buoyancy mesh'].density = 1.0


s.new_tank('WBT1.S', parent = 'Nato Ponton')
s['WBT1.S'].trimesh.load_obj(r'nato ponton tank.obj')
s['WBT1.S'].density = 0.985

s.new_tank('WBT1.P', parent = 'Nato Ponton')
s['WBT1.P'].trimesh.load_obj(r'nato ponton tank.obj', offset = (0.0,2.
1,0.0))
s['WBT1.P'].density = 0.985

# apply tank fillings
s['WBT1.S'].fill_pct = 50
s['WBT1.P'].fill_pct = 10


# Make points to measure the trim and draft
s.new_point('stern',parent = 'Nato Ponton', position = (0,0,0))
s.new_point('bow',parent = 'Nato Ponton', position = (13.640,0,0));
```

Solve the system

Keep the barge fixed in the horizontal plane (X and Y). Release all other 4 degrees of freedom.

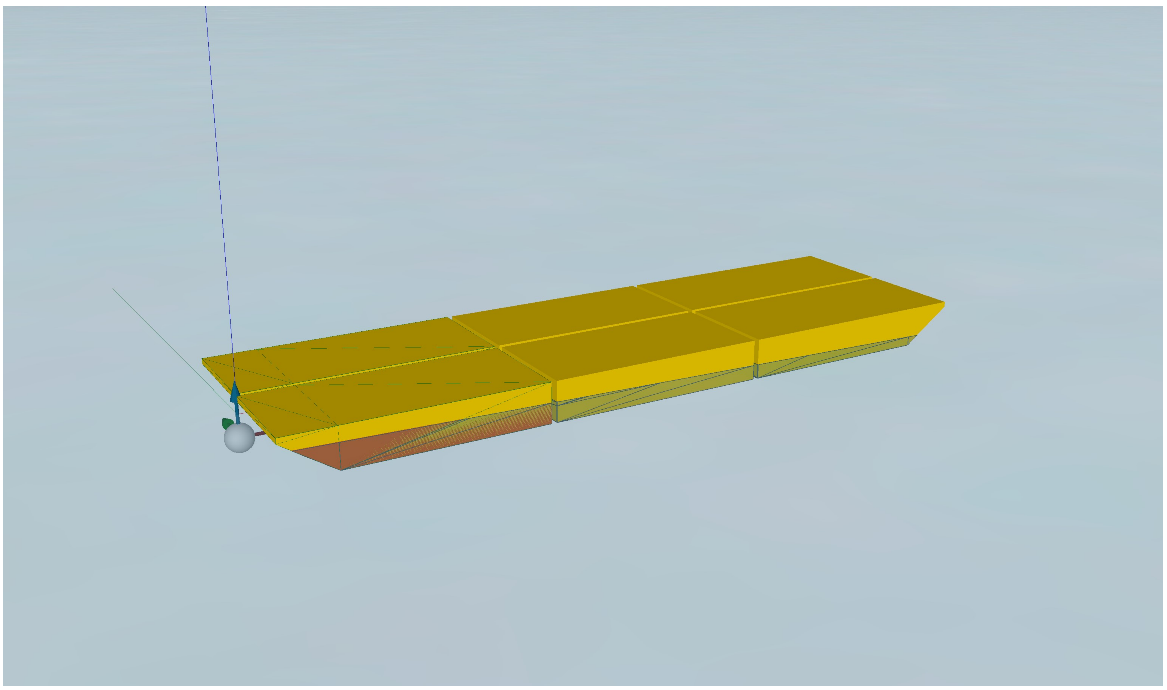
In [4]:
```
s['Nato Ponton'].fixed = (True, True, False, False, False, False)
s.solve_statics();
```

```
Solved to 1.1411827927076956e-08.
```

Picture of the free floating condition

In [5]:
```
show(s, sea = True, camera_pos = (-5.135726056735549, -19.8294950673216
9, 6.855145988597425), lookat = (6.796557172523581, 0.545191844349296,
0.016953689853040091), force_normalize = True, force_scale = 1.6, cog_sc
ale = 0.3090056685321995)
```

```
cob = (2.553039621893395, -1.095823498679798, -0.1815466087332506)
cob = (2.3979161259960877, 0.8760794601884401, -0.2571582530352776)
```

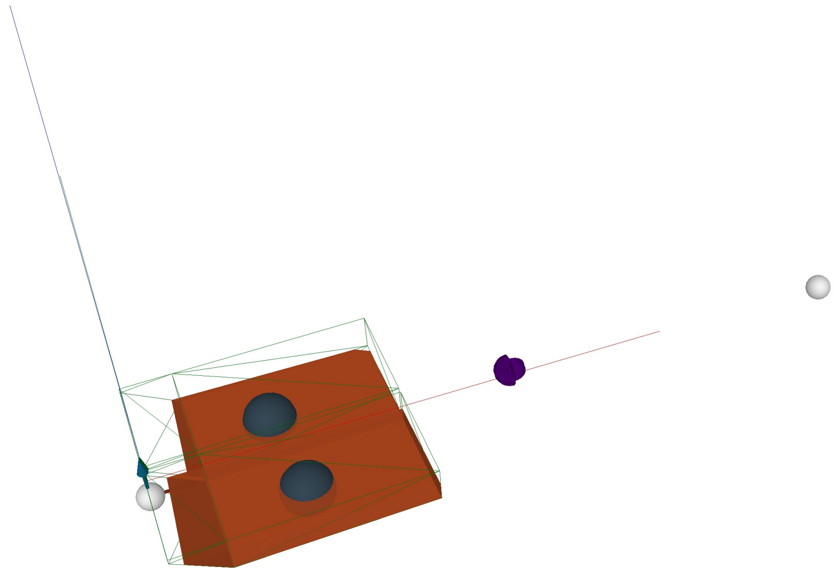


And another one with the buoaycny mesh disabled such that we can see the contents of the tanks.

The purple sphere is the CoG of the barge. The blue spheres are the cogs of the tank contents. The white spheres are the points we defined at the stern and bow.

In [6]:
```python
s['Buoyancy mesh'].visible = False
show(s, sea = False, camera_pos = (0.043895062013894315, -16.243569387411746, 16.65938089398565), lookat = (7.169258583546209, 0.5400134579295901, 0.17276009753098043), force_normalize = True, force_scale = 1.6, cog_scale = 0.3090056685321995)
```

```
cob = (2.553039621893395, -1.095823498679798, -0.1815466087332506)
cob = (2.3979161259960877, 0.8760794601884401, -0.2571582530352776)
```



Compare results

Tank fillings:

TANK STATUS							
Trim: Aft 0.344/13.640, Heel: Stbd 2.36 deg.							
Part	Load	SpGr	Weight(MT)	LCG	TCG	VCG	RefHt
WBT1.P	0.100	1.000	0.62	2.395f	0.877p	0.050	-0.195
WBT1.S	0.500	1.000	3.10	2.555f	1.089s	0.204	-0.412
Total Tanks			3.72	2.529f	0.761s	0.178	
Distances in METERS.							

In [7]:

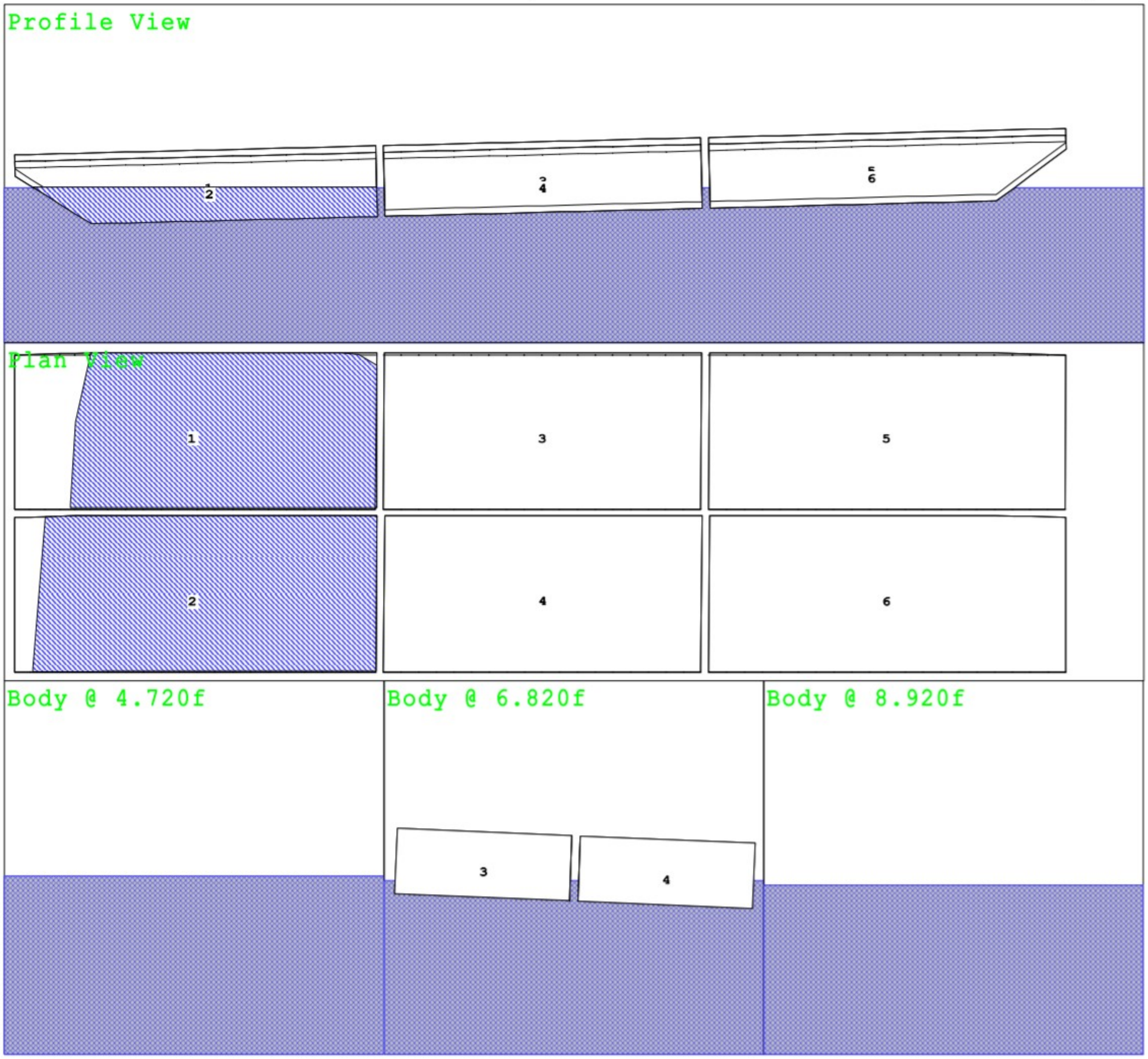
```
wbt1p = s['WBT1.P']
wbt1s = s['WBT1.S']


from prettytable import PrettyTable

x = PrettyTable()

x.field_names = ["What","DAVE","GHS"]

x.add_row(['WBT1.P Weight', f'{wbt1p.volume * wbt1p.density:.2f} mT', '
0.62 mT'])
x.add_row(['WBT1.P LCG', f'{wbt1p.cog_local[0]:.3f}', '2.395'])
x.add_row(['WBT1.P TCG', f'{wbt1p.cog_local[1]:.3f}', '0.877'])
x.add_row(['WBT1.P VCG', f'{wbt1p.cog_local[2]:.3f}', '0.050'])

x.add_row(['WBT1.S Weight', f'{wbt1s.volume * wbt1s.density:.2f} mT', '
3.10 mT'])
x.add_row(['WBT1.S LCG', f'{wbt1s.cog_local[0]:.3f}', '2.555'])
x.add_row(['WBT1.S TCG', f'{wbt1s.cog_local[1]:.3f}', '1.089'])
x.add_row(['WBT1.S VCG', f'{wbt1s.cog_local[2]:.3f}', '0.204'])

from IPython.core.display import HTML
HTML(x.get_html_string())
```

Out[7]:

What	DAVE	GHS
WBT1.P Weight	0.62 mT	0.62 mT
WBT1.P LCG	2.401	2.395
WBT1.P TCG	0.879	0.877
WBT1.P VCG	0.051	0.050
WBT1.S Weight	3.10 mT	3.10 mT
WBT1.S LCG	2.558	2.555
WBT1.S TCG	-1.088	1.089
WBT1.S VCG	0.204	0.204

Free floating condition

CG - Draft: 0.061 @ 13.640f, 0.405 @ 0.000   Heel: stbd 2.36 deg.



Tanks

1 WBT1.P..10% FRESH WATER
2 WBT1.S..50% FRESH WATER
3 WBT2.P...0% FRESH WATER
4 WBT2.S...0% FRESH WATER
5 WBT3.P...0% FRESH WATER
6 WBT3.S...0% FRESH WATER

In [8]:
```python
x = PrettyTable()

x.field_names = ["What","DAVE","GHS"]

x.add_row(['Heel [degrees]', f"{s['Nato Ponton'].heel:.3f}", '2.36'])
x.add_row(['Draft at 13.64 [m]', f"{s['bow'].gz:.3f}", '-0.061'])
x.add_row(['Draft at 0.000 [m]', f"{s['stern'].gz:.3f}", '-0.405'])

HTML(x.get_html_string())
```

Out[8]:

What	DAVE	GHS
Heel [degrees]	2.371	2.36
Draft at 13.64 [m]	-0.062	-0.061
Draft at 0.000 [m]	-0.404	-0.405

Hydrostatic properties

HYDROSTATIC PROPERTIES

Trim: Aft 0.344/13.640, Heel: Stbd 2.36 deg., VCG = 0.313

LCF Draft	Displacement Weight(MT)	Buoyancy-Ctr. LCB	VCB	Weight/ cm	LCF	Moment/ cm trim	GML	GMT
0.239	11.22	5.393f	0.143	0.49	6.579f	0.45	54.33	5.618

Distances in METERS. Specific Gravity = 1.000. Moment in m.-MT.
Trim is per 13.64m.
Draft is from Baseline. Free Surface included. GMT is from RA curve.

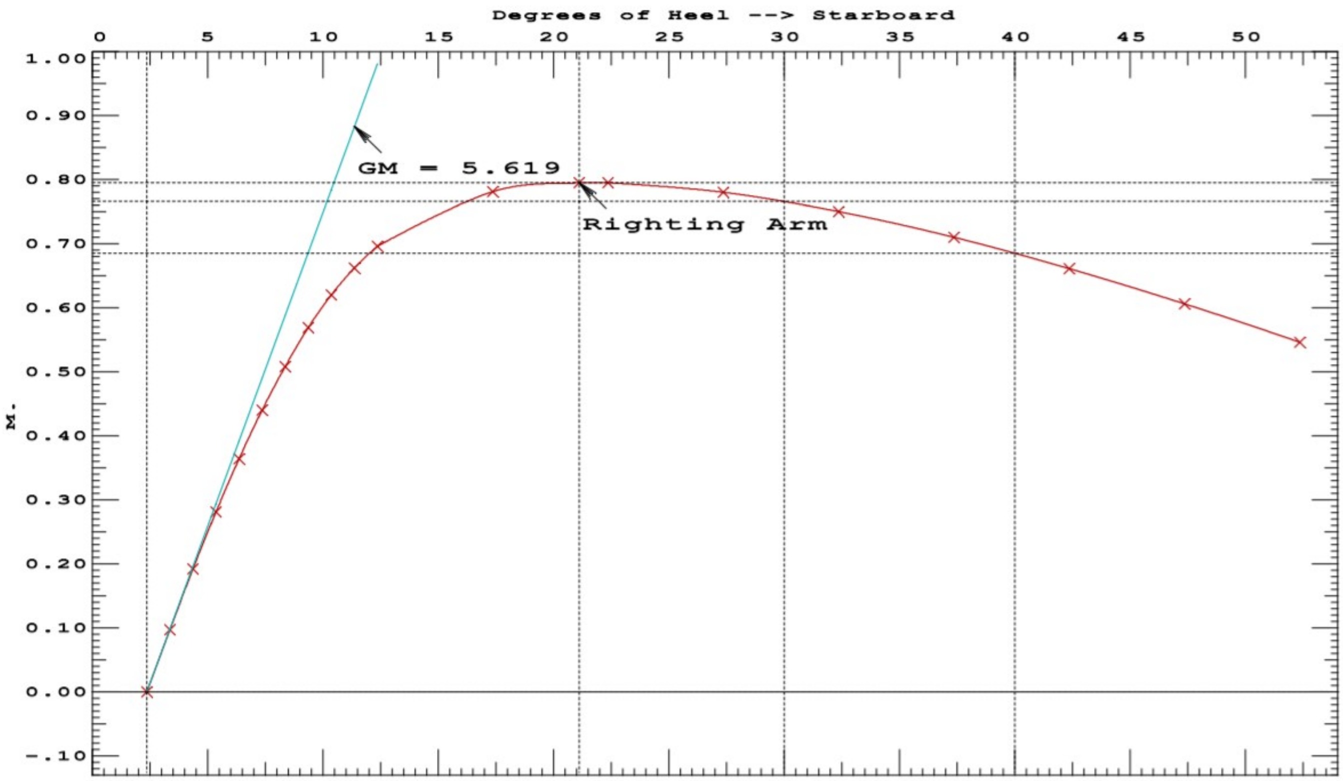
In [9]:
```python
displacement_m3 = s['Buoyancy mesh'].displacement
cob_local = s['Buoyancy mesh'].cob_local
cob_global = s['Buoyancy mesh'].cob
```

In [10]:
```python
x = PrettyTable()

x.field_names = ["What","DAVE","GHS"]
x.add_row(['Displacement [mT]', f"{displacement_m3:.2f}", '11.22'])
x.add_row(['LCB [m]', f"{cob_local[0]:.3f}", '5.393'])
x.add_row(['VCB [m]', f"{cob_local[2]:.3f}", '0.143'])

HTML(x.get_html_string())
```

Out[10]:

What	DAVE	GHS
Displacement [mT]	11.22	11.22
LCB [m]	5.394	5.393
VCB [m]	0.143	0.143

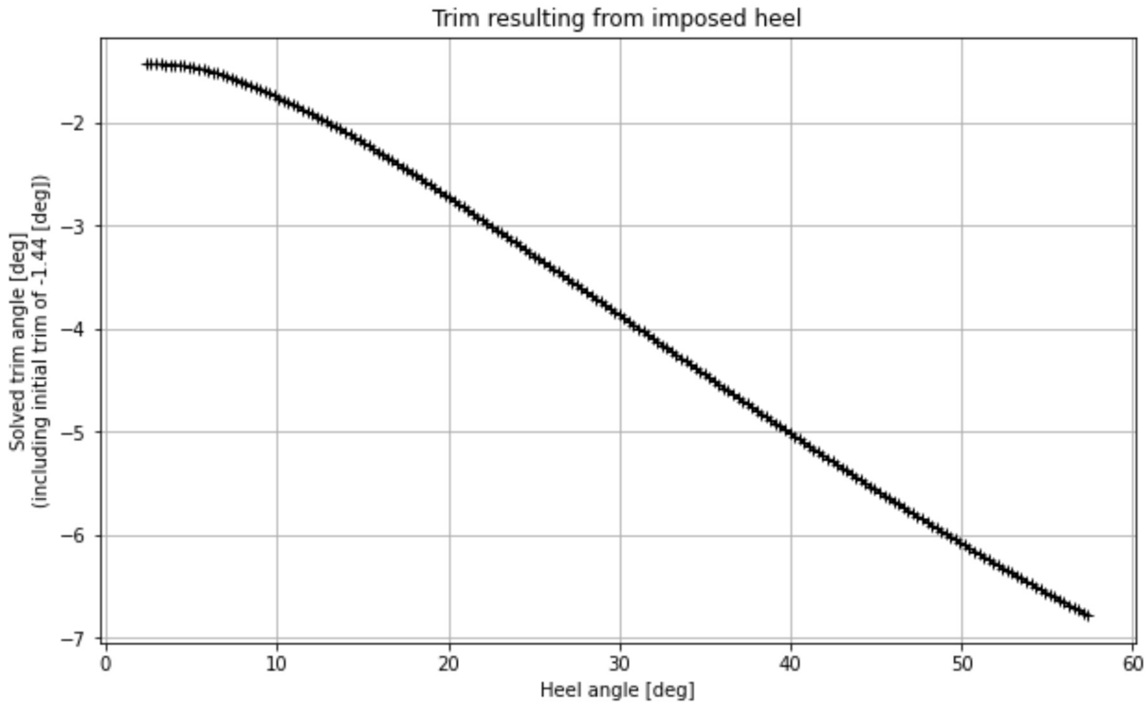
Stability curves

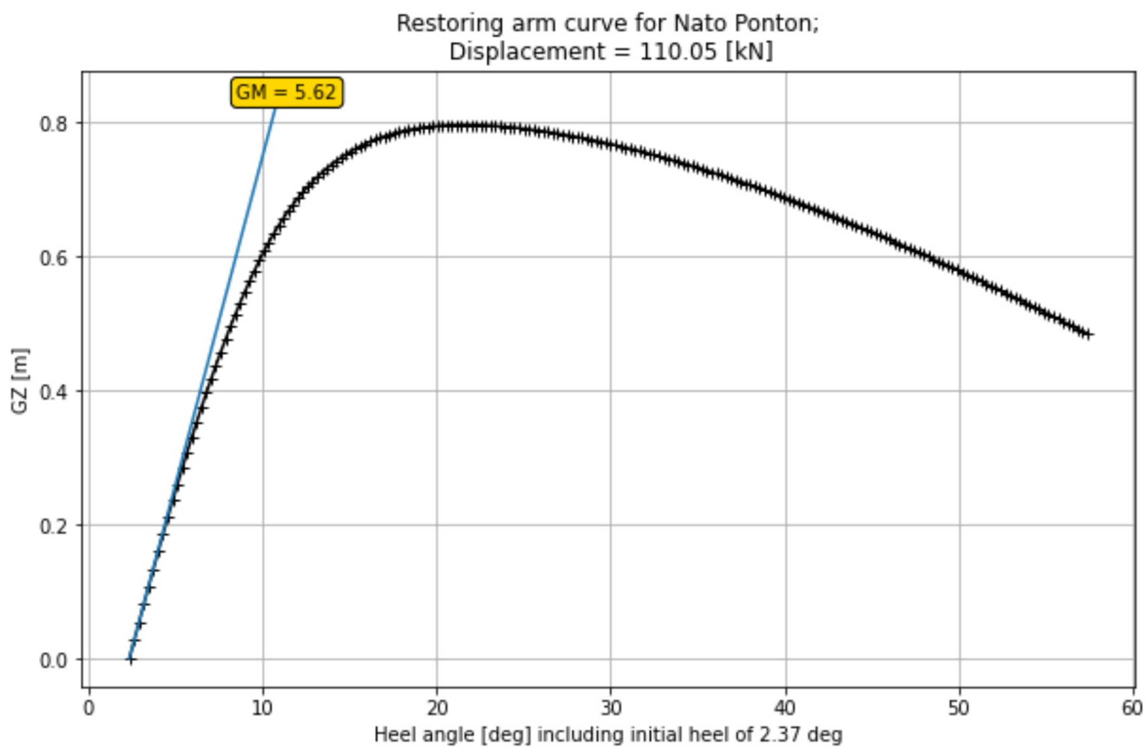


In [11]:

```
# Set matplotlib figure size
import matplotlib.pyplot as plt
plt.rcParams['figure.figsize'] = [10, 6]

from DAVE.marine import GZcurve_DisplacementDriven
GZcurve_DisplacementDriven(scene = s,
                    noshow = True,
                    vessel_node = "Nato Ponton",
                    displacement_kN=9.81*displacement_m3,
                    minimum_heel= 0,
                    maximum_heel=55,
                    steps=200,
                    teardown=True,
                    allow_surge=False,
                    allow_sway=False,
                    allow_yaw=False,
                    allow_trim=True);

# Note: DAVE derives the GM from the two points nearest to the equilibr
ium condition.
# So the exact linearization depends on the number of points
```

```
Solved to 1.0118640147993574e-08.
```





Using paint to put the two pictures on top of eachother gives