



SHIPFLOW耐波性计算方法介绍与案例

2023-5-25

01

常规船型IGES模型波浪增阻与运动计算方法

- 静水阻力
- 规则波/不规则波阻力
- 波浪增阻

02

特殊船型IGES模型波浪增阻与运动计算方法

- 静水阻力
- 规则波/不规则波阻力
- 波浪增阻

01

常规船型IGES模型波浪增阻与运动计算方法

计算模型

案例采用不带桨和舵的KCS标模

缩尺比	1:1 (实尺度)
垂线间长	230m
吃水	10.8m
航速	24knots
Fn	0.26
ZCG	14.3m
转动惯量Kyy	0.252Lpp
运动自由度	垂荡和纵摇 (heave&pitch)
IGES文件路径	D:\SOFT\FLOWTECH\SHIPFLOW7.0.17-x86_64\examples_motions\geometry

*数据来源: Tokyo 2015 CFD Workshop



静水阻力计算设置—文件同步

特别说明：对于使用CAESES的SHIPFLOW接口进行计算设置的情况，需要同步CAESES软件的指令文件，否则将无法使用SHIPFLOW新版本的功能。

CAESES4同步流程：

1. 复制shipflowDefinition.cfg文件，文件位置参考：

名称	修改日期	类型	大小
bin	2022/10/18 10:34	文件夹	
data	2022/10/18 10:34	文件夹	
doc	2022/10/18 10:34	文件夹	
examples	2022/10/18 10:34	文件夹	
examples_motions	2022/10/18 10:34	文件夹	
Framework	2022/10/18 10:33	文件夹	
npp	2022/10/18 10:34	文件夹	
ParaView 5.10.0	2022/10/18 10:34	文件夹	
redist	2022/10/18 10:34	文件夹	
tutorials	2022/10/18 10:34	文件夹	
xwizard	2022/10/18 10:34	文件夹	
License_CGNS.txt	2014/5/12 19:04	文本文档	2 KB
License_Paraview.txt	2022/3/4 2:14	文本文档	1 KB
License_VTK.txt	2014/5/12 19:04	文本文档	2 KB
MSMpiSetup.exe	2018/9/21 17:50	应用程序	6,086 KB
shipflow.ini	2014/4/24 22:00	配置设置	1 KB
SHIPFLOW	2022/10/18 10:34	Internet 快捷方式	1 KB
shipflowDefinition.cfg	2022/8/18 3:00	CFG 文件	344 KB
uninst.exe	2022/10/18 10:34	应用程序	64 KB
vcredist_x64_2015.exe	2016/4/27 20:41	应用程序	14,427 KB
vcredist_x86_2010.exe	2012/2/25 1:16	应用程序	4,955 KB

2. 拷贝文件到CAESES安装路径中，替换已经存在的shipflowDefinition.cfg文件，文件位置参考：

名称	修改日期	类型	大小
kspline.cfg	2019/5/9 21:03	CFG 文件	2 KB
meta.cfg	2019/5/9 21:03	CFG 文件	2 KB
nax.cfg	2019/5/9 21:03	CFG 文件	2 KB
nushallo.cfg	2019/5/9 21:03	CFG 文件	3 KB
nushalloDefinition.cfg	2019/5/9 21:03	CFG 文件	32 KB
opennurbs.cfg	2019/5/9 21:03	CFG 文件	2 KB
opt.cfg	2019/5/9 21:03	CFG 文件	11 KB
optmo.cfg	2019/5/9 21:03	CFG 文件	2 KB
parax.cfg	2019/5/9 21:03	CFG 文件	2 KB
seakeeptools.cfg	2019/5/9 21:03	CFG 文件	2 KB
shipflow.cfg	2019/5/9 21:03	CFG 文件	3 KB
shipflow.ini	2019/5/9 21:03	配置设置	1 KB
shipflowDefinition.cfg	2022/5/6 21:33	CFG 文件	347 KB
shipflowDefinition40.cfg	2019/5/9 21:03	CFG 文件	152 KB
shipflowDefinition41.cfg	2019/5/9 21:03	CFG 文件	156 KB
shipflowDefinition43.cfg	2019/5/9 21:03	CFG 文件	180 KB
shipflowDefinition44.cfg	2019/5/9 21:03	CFG 文件	180 KB
shipflowDefinition45.cfg	2019/5/9 21:03	CFG 文件	165 KB
shipflowDefinition46.cfg	2019/5/9 21:03	CFG 文件	170 KB
sshrm.cfg	2019/5/9 21:03	CFG 文件	2 KB
xfl.cfg	2019/5/9 21:03	CFG 文件	2 KB
xfl.dtd	2019/5/9 21:03	DTD 文件	8 KB
yachtDefinition.cfg	2019/5/9 21:03	CFG 文件	16 KB



静水阻力计算设置—文件同步

CAESES5同步流程:

1. 复制shipflowDefinition.cfg文件，文件位置参考：

此电脑 > DATA1 (D:) > SOFT > FLOWTECH > SHIPFLOW7.0.17-x86_64

名称	修改日期	类型	大小
bin	2022/10/18 10:34	文件夹	
data	2022/10/18 10:34	文件夹	
doc	2022/10/18 10:34	文件夹	
examples	2022/10/18 10:34	文件夹	
examples_motions	2022/10/18 10:34	文件夹	
Framework	2022/10/18 10:33	文件夹	
npp	2022/10/18 10:34	文件夹	
ParaView 5.10.0	2022/10/18 10:34	文件夹	
redist	2022/10/18 10:34	文件夹	
tutorials	2022/10/18 10:34	文件夹	
xwizard	2022/10/18 10:34	文件夹	
License_CGNS.txt	2014/5/12 19:04	文本文档	2 KB
License_Paraview.txt	2022/3/4 2:14	文本文档	1 KB
License_VTK.txt	2014/5/12 19:04	文本文档	2 KB
MSMpisetup.exe	2018/9/21 17:50	应用程序	6,086 KB
shipflow.ini	2014/4/24 22:00	配置设置	1 KB
SHIPFLOW	2022/10/18 10:34	Internet 快捷方式	1 KB
shipflowDefinition.cfg	2022/8/18 3:00	CFG 文件	344 KB
uninst.exe	2022/10/18 10:34	应用程序	64 KB
vc_redist_x64_2015.exe	2016/4/27 20:41	应用程序	14,427 KB
vc_redist_x86_2010.exe	2012/2/25 1:16	应用程序	4,955 KB

2. 拷贝文件到CAESES安装路径中，替换已经存在的shipflowDefinition.cfg文件，文件位置参考：

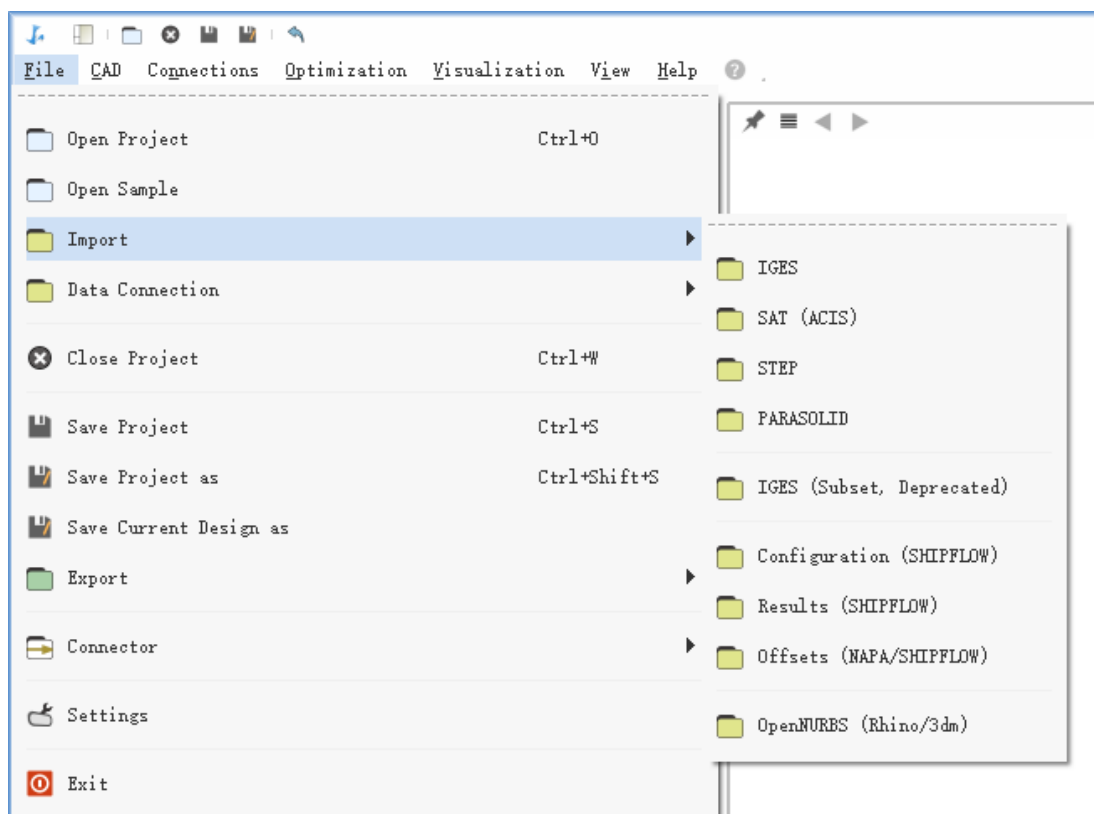
此电脑 > DATA1 (D:) > SOFT > CAESES5 > etc > definitions > shipflow

名称	修改日期	类型	大小
shipflow.linux	2022/12/8 20:54	LINUX 文件	3 KB
shipflow.win	2022/12/8 20:54	WIN 文件	3 KB
shipflowDefinition.cfg	2022/12/8 20:54	CFG 文件	219 KB
shipflowDefinition40.cfg	2022/12/8 20:54	CFG 文件	159 KB
shipflowDefinition41.cfg	2022/12/8 20:54	CFG 文件	163 KB
shipflowDefinition43.cfg	2022/12/8 20:54	CFG 文件	187 KB
shipflowDefinition44.cfg	2022/12/8 20:54	CFG 文件	187 KB
shipflowDefinition45.cfg	2022/12/8 20:54	CFG 文件	172 KB
shipflowDefinition46.cfg	2022/12/8 20:54	CFG 文件	177 KB
shipflowDefinition47.cfg	2022/12/8 20:54	CFG 文件	180 KB
shipflowDefinition50.cfg	2022/12/8 20:54	CFG 文件	177 KB
shipflowDefinition51.cfg	2022/12/8 20:54	CFG 文件	183 KB
shipflowDefinition52.cfg	2022/12/8 20:54	CFG 文件	210 KB
shipflowDefinition61.cfg	2022/12/8 20:54	CFG 文件	215 KB
shipflowDefinition62.cfg	2022/12/8 20:54	CFG 文件	215 KB
shipflowDefinition63.cfg	2022/12/8 20:54	CFG 文件	219 KB

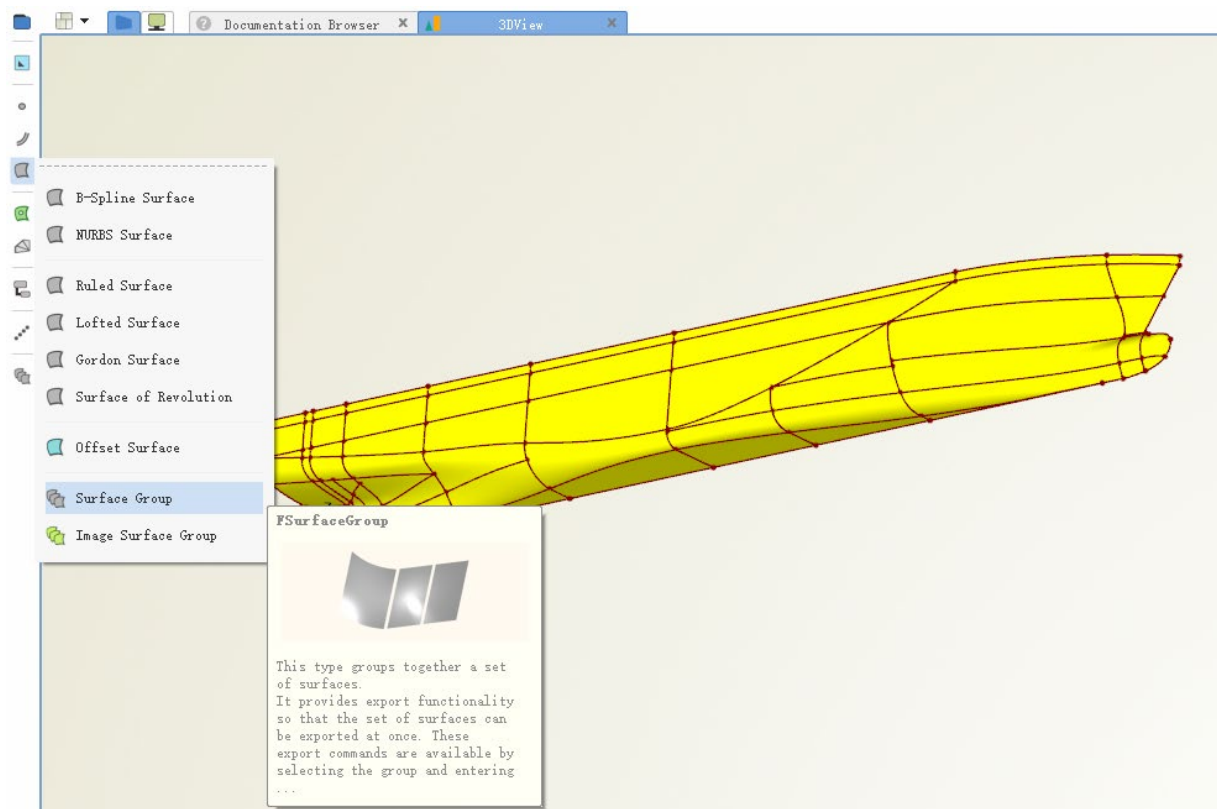


静水阻力计算设置—导入IGES模型

- 开始菜单运行SHIPFLOW design
- 导入船体几何，格式IGES



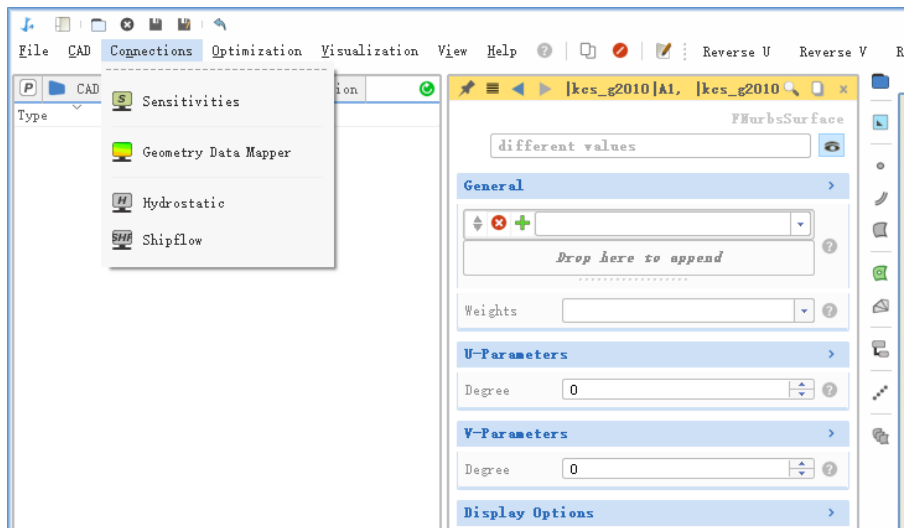
- 选择所有面，创建surface group



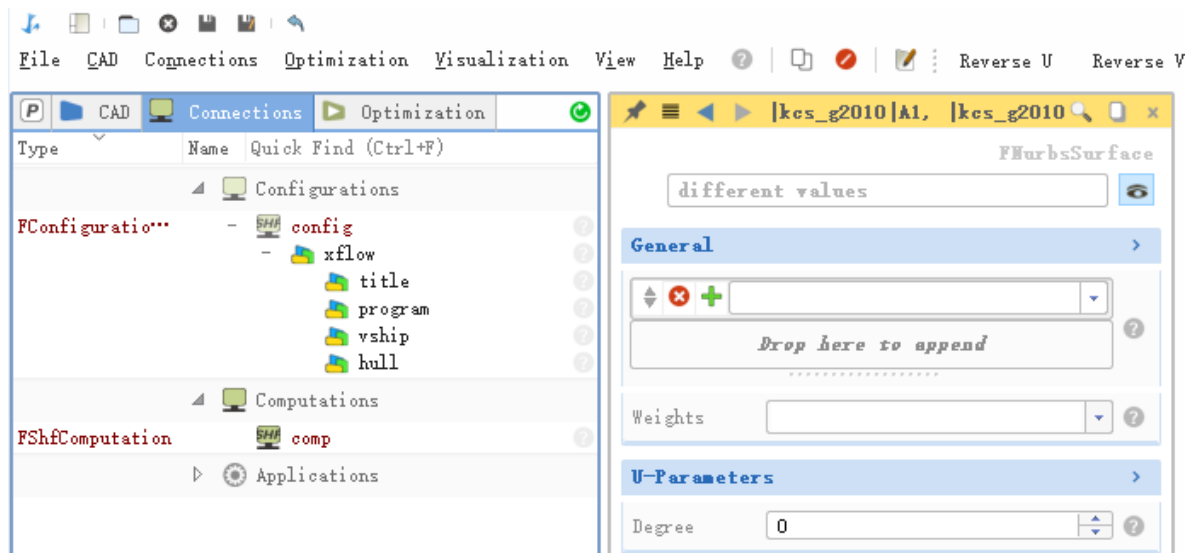


静水阻力计算设置—新建设置

- 点击Connections下面的Shipflow新建设置

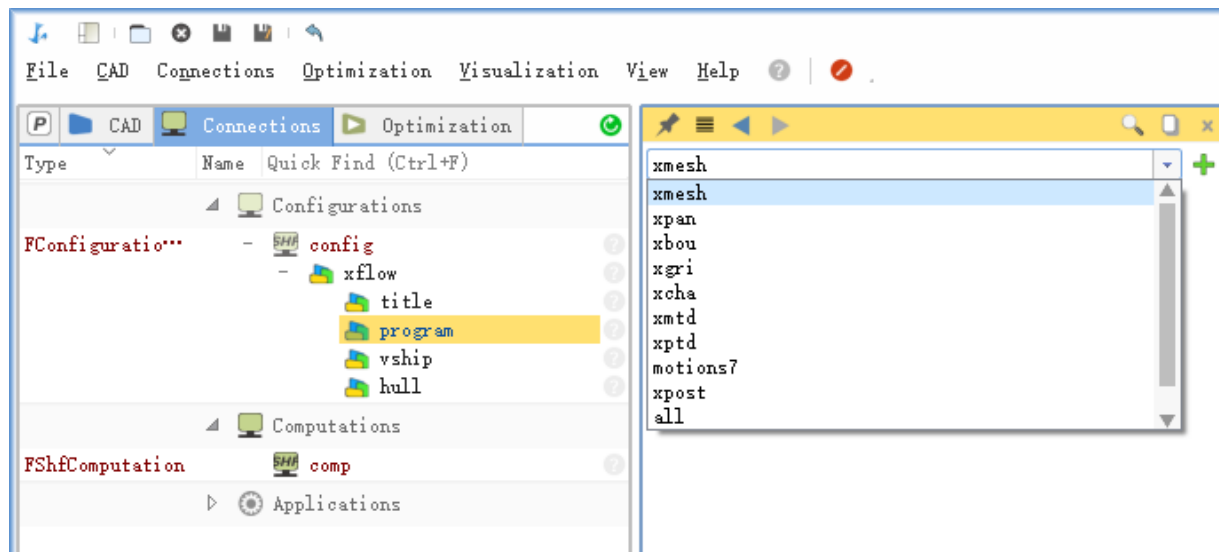


- 展开config>>xflow

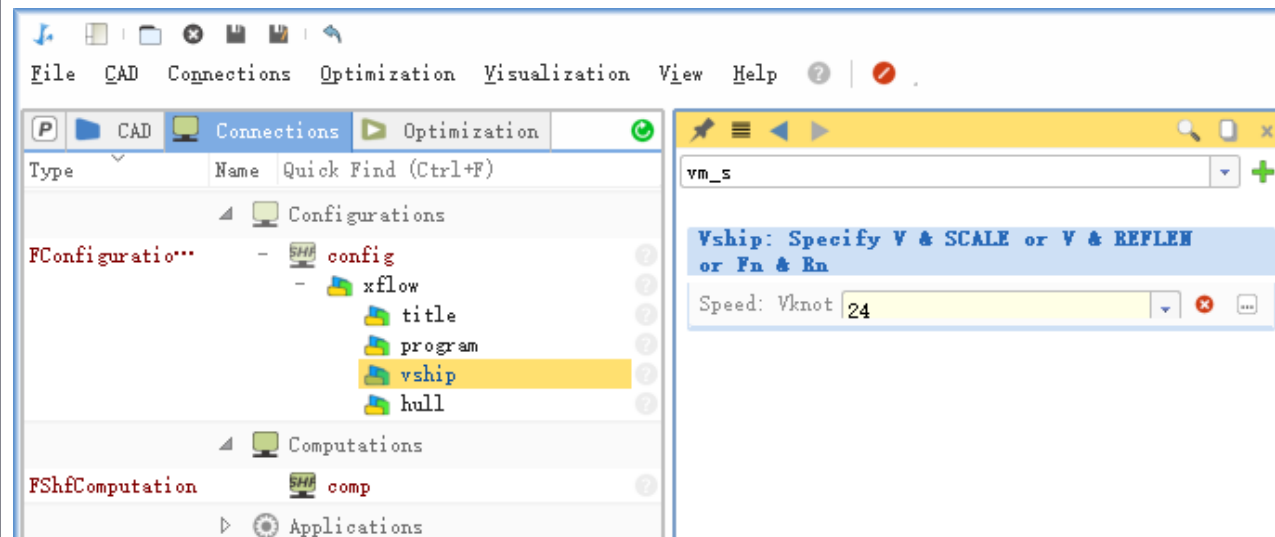


静水阻力计算设置—选择耐波性程序&设置航速

- 点击xflow>>program，下拉菜单中选择motions7，点击绿色加号添加

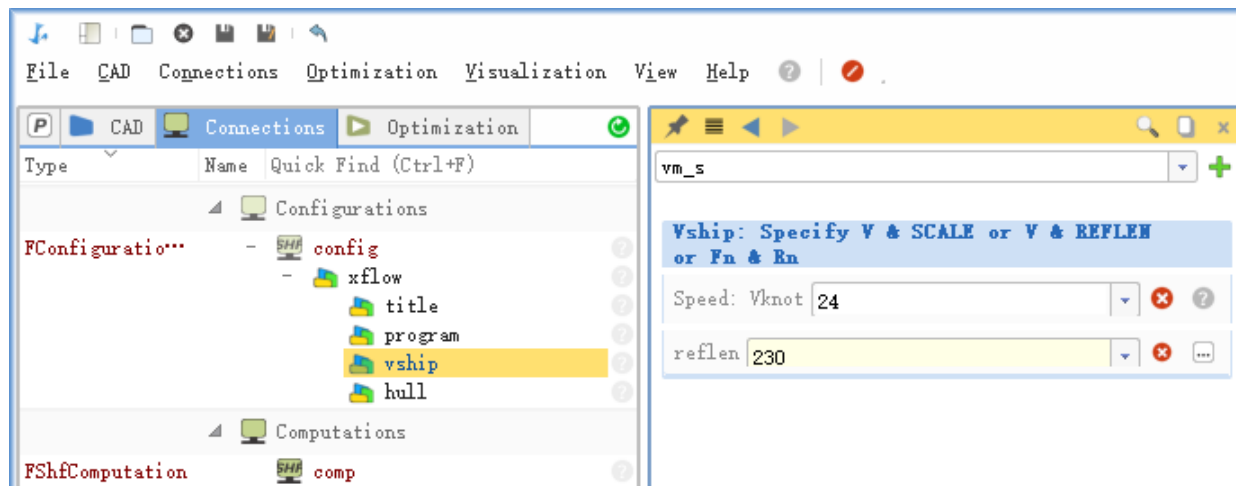


- 点击xflow>>vship，下拉菜单中选择vknot，设置航速24

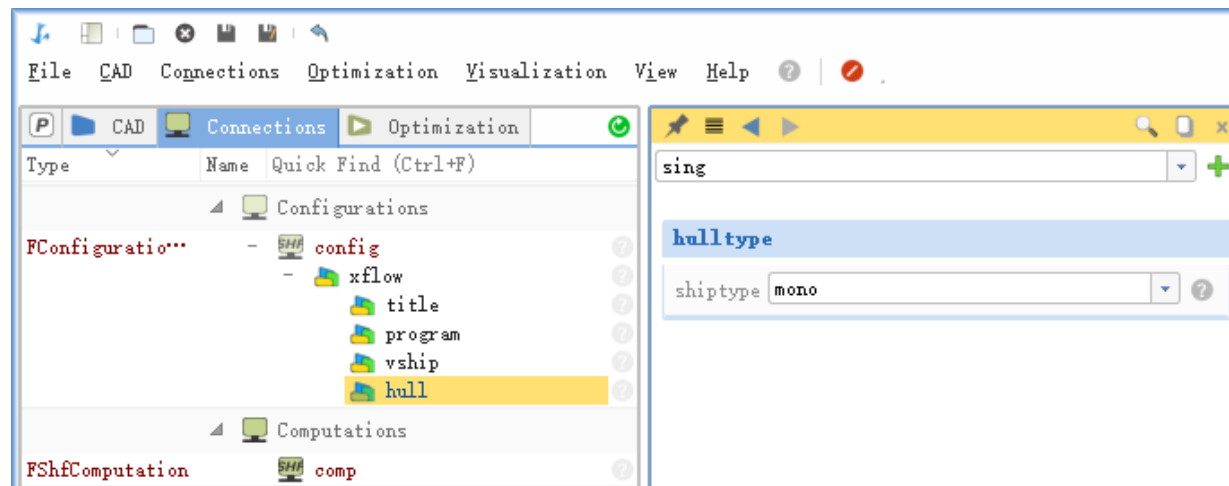


静水阻力计算设置—设置缩尺比&指定船型

- 点击xflow>>vship, 下拉菜单中选择reflen, 设置230, 或者选择scale, 设置1, 两者等效

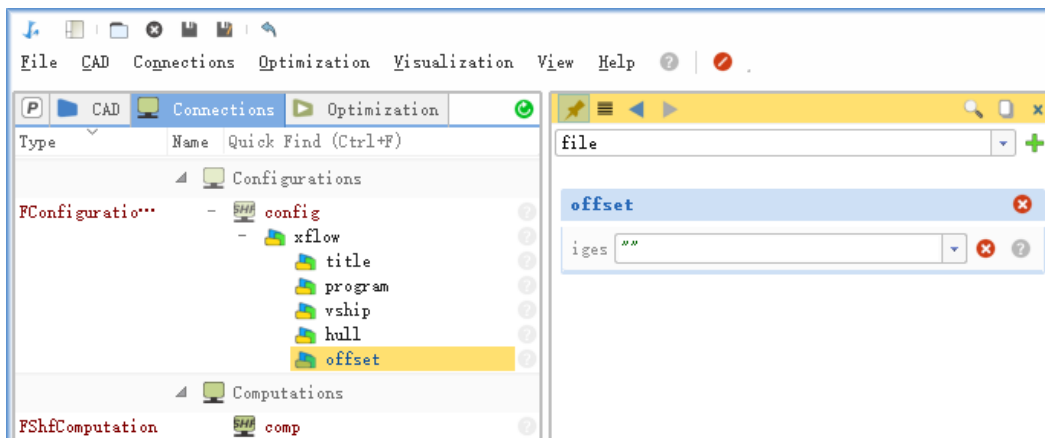
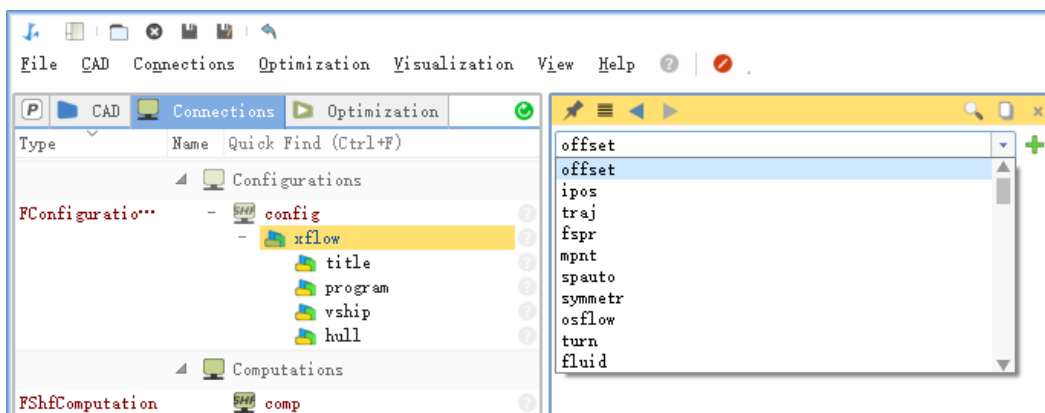


- 点击xflow>>hull, shiptype默认mono, 即单体船

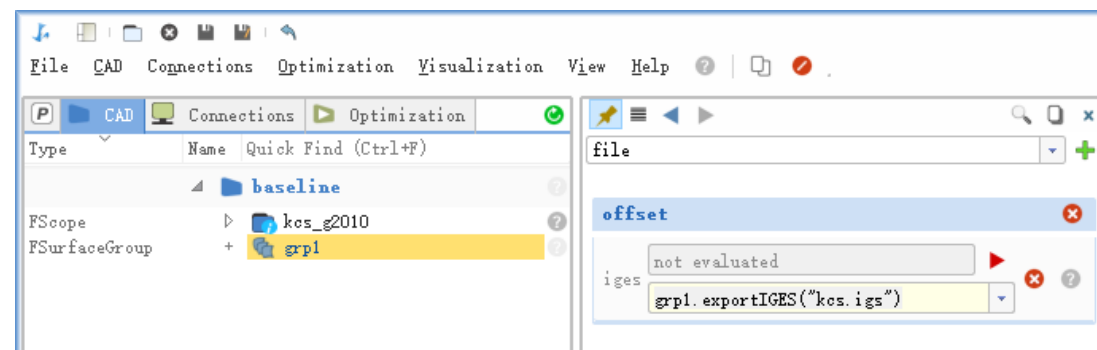
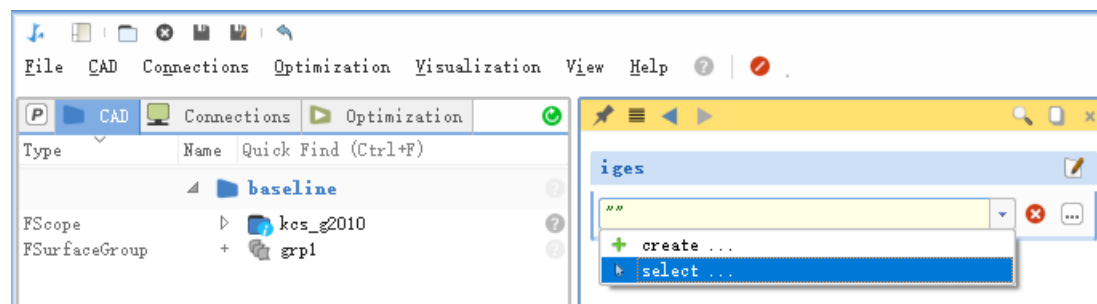


静水阻力计算设置—IGES模型输入输出

- 点击xflow, 下拉菜单中选择offset
- 点击xflow>>offset, 下拉菜单中选择iges



- 点击offset>>iges输入框下拉菜单, 选择select
- 点击CAD, 选择grp1
- 在offset>>iges输入框中输入grp1.exportIGES("kcs.igs")

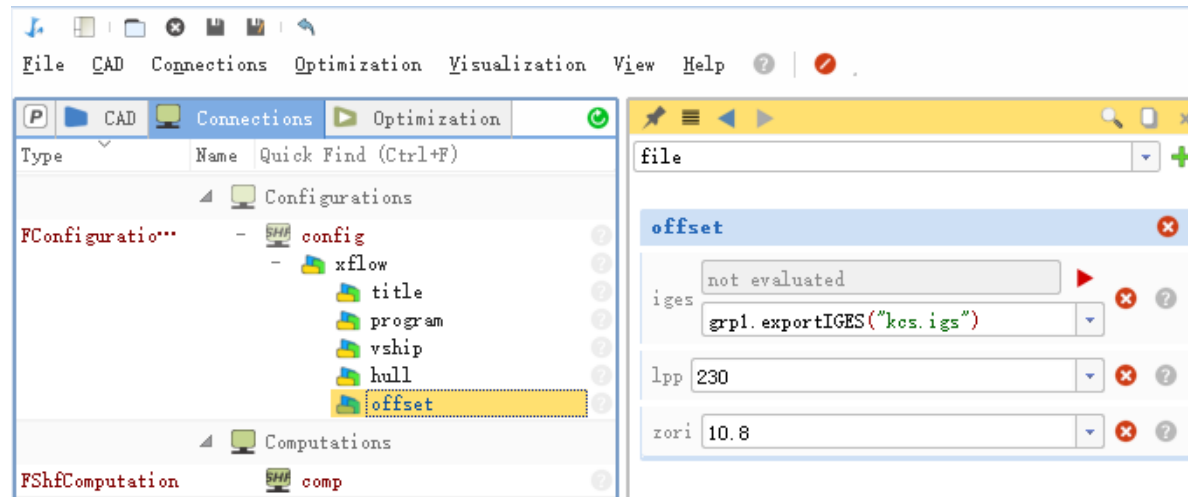
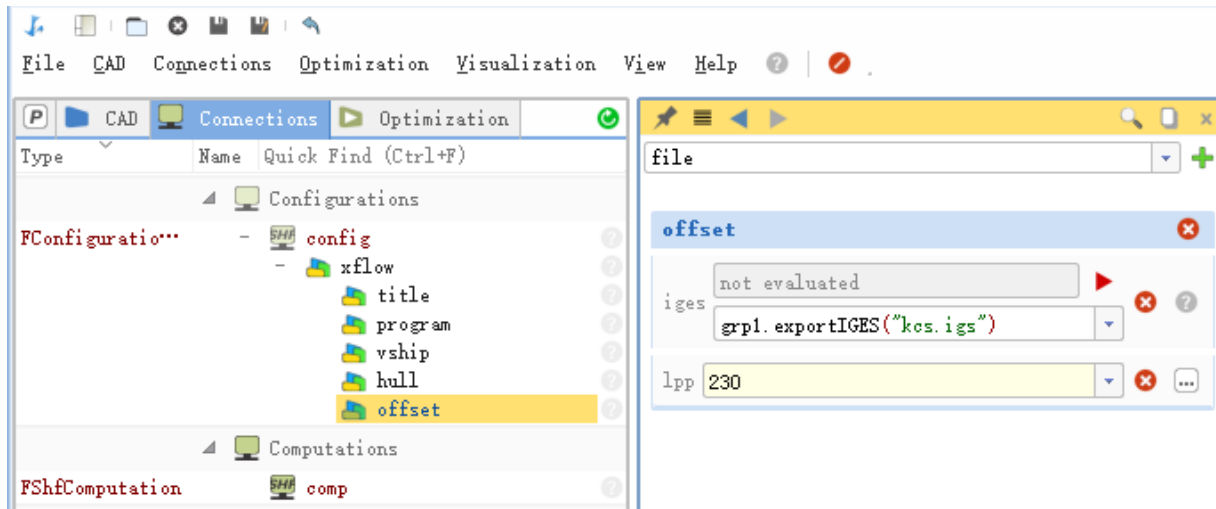




静水阻力计算设置—设置船长和吃水

- 点击xflow>>offset, 下拉菜单中选择lpp, 输入230

- 点击xflow>>offset, 下拉菜单中选择zori, 输入10.8

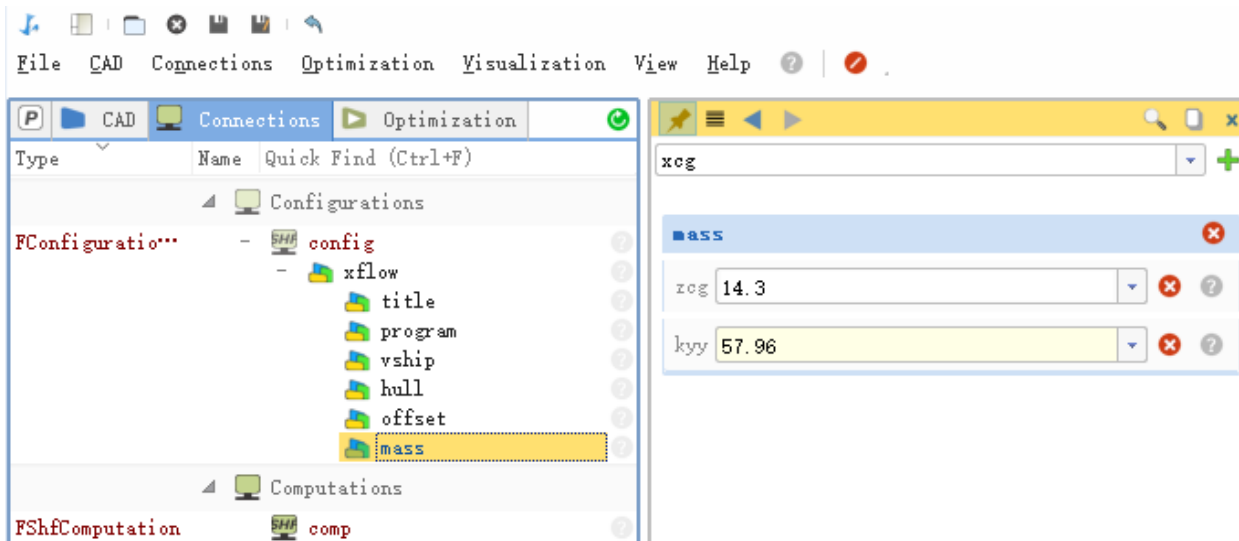
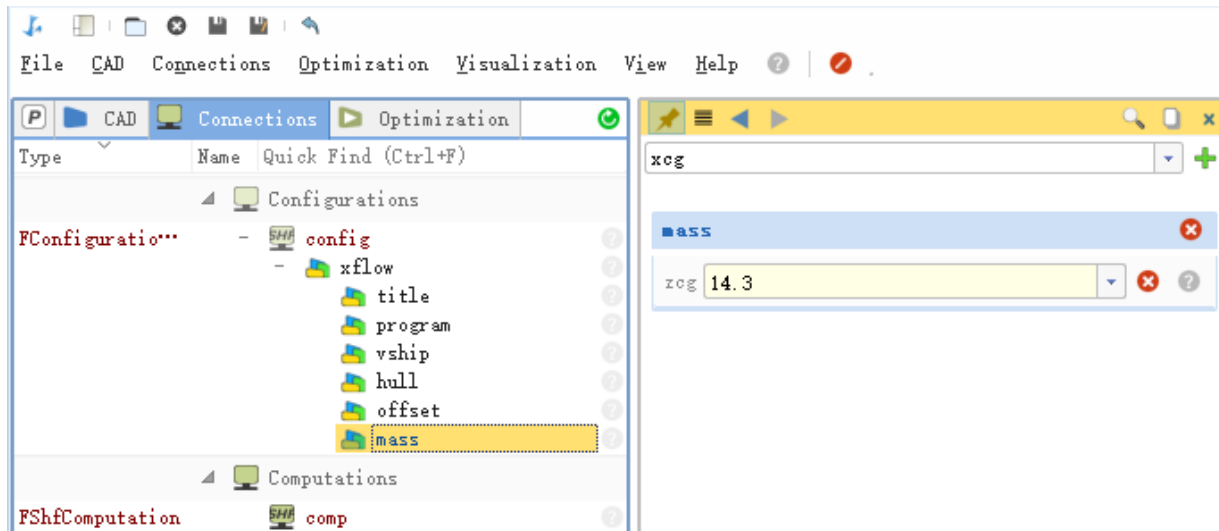




静水阻力计算设置—设置质量属性

- 点击xflow，下拉菜单中选择mass
- 点击xflow>>mass，下拉菜单中选择zcg，输入14.3

- 点击xflow>>mass，下拉菜单中选择kyy，输入57.96

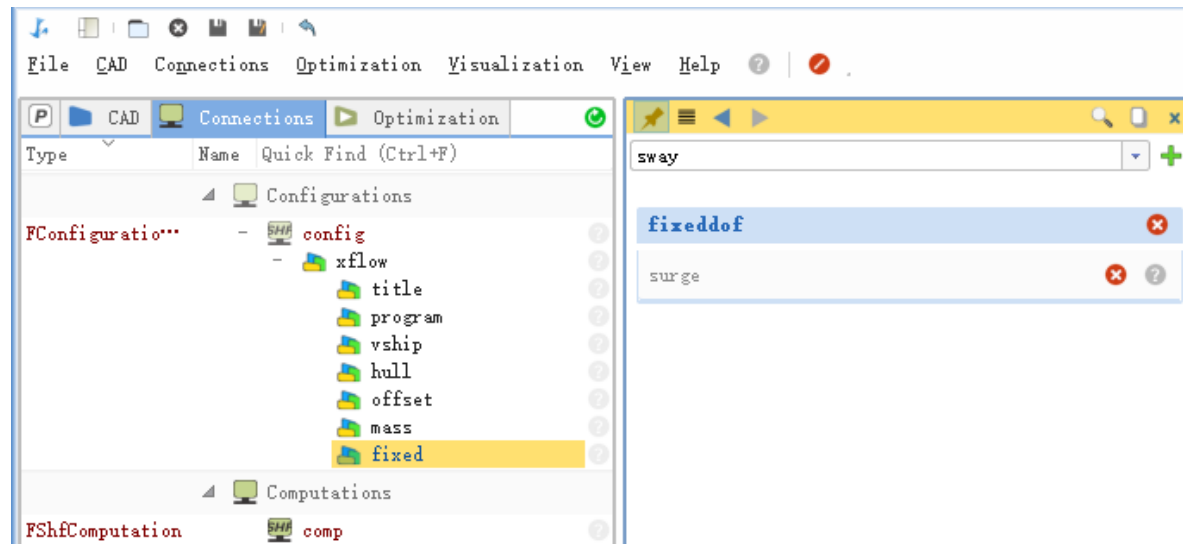
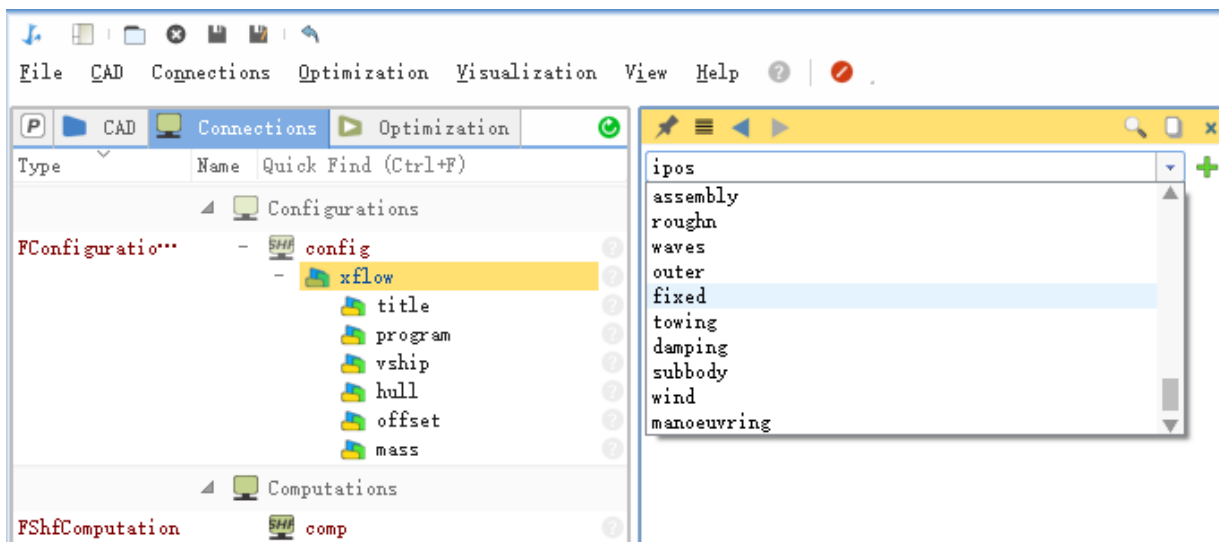




静水阻力计算设置—设置运动自由度

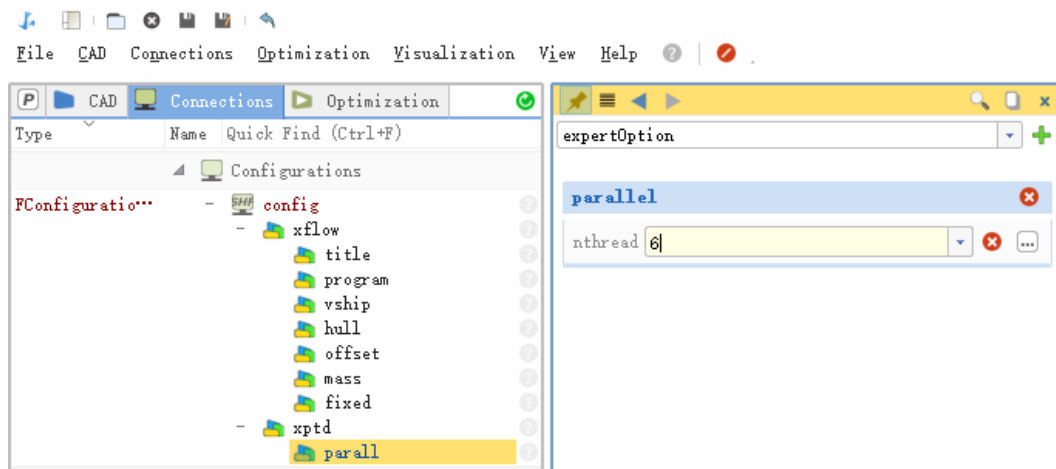
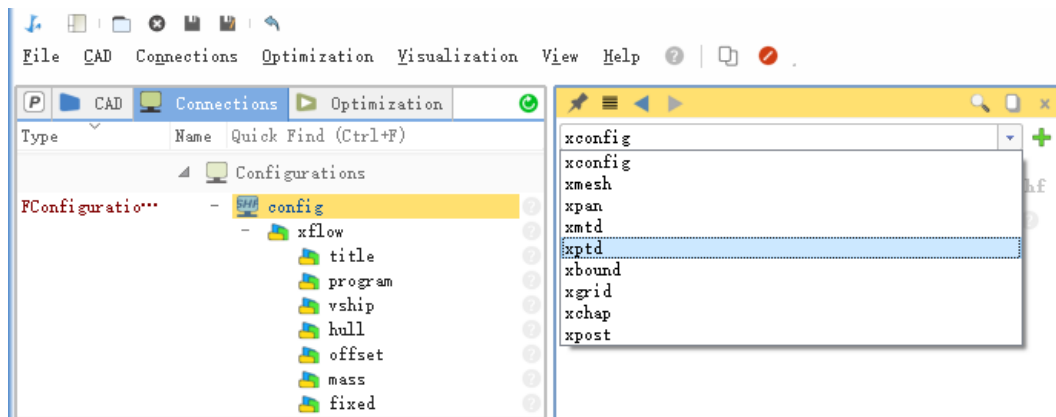
- 半船、对称条件，因此sway，roll和yaw三个自由度默认固定
- 点击xflow，下拉菜单中选择fixed

- 点击xflow>>fixed，下拉菜单中选择surge，固定此自由度
- 仅开放heave和pitch两个自由度

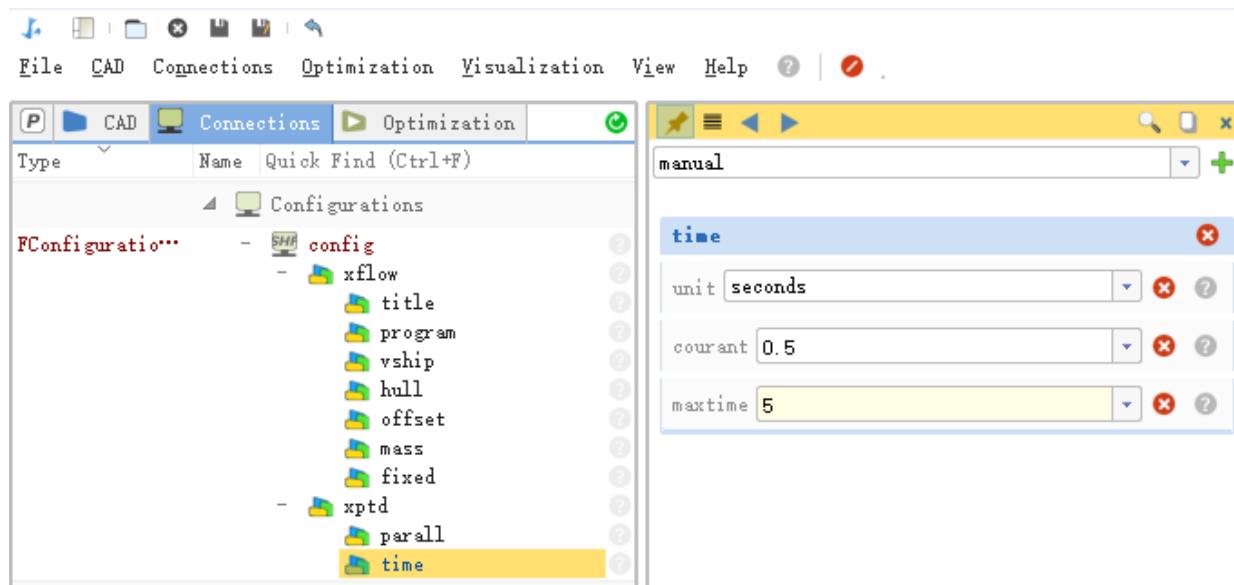


静水阻力计算设置—求解设置

- 点击config，下拉菜单中选择xptd
- 点击config>>xptd，下拉菜单中选择parall
- 展开config>>xptd，点击parall，下拉菜单中选择nthread，设置并行计算线程数



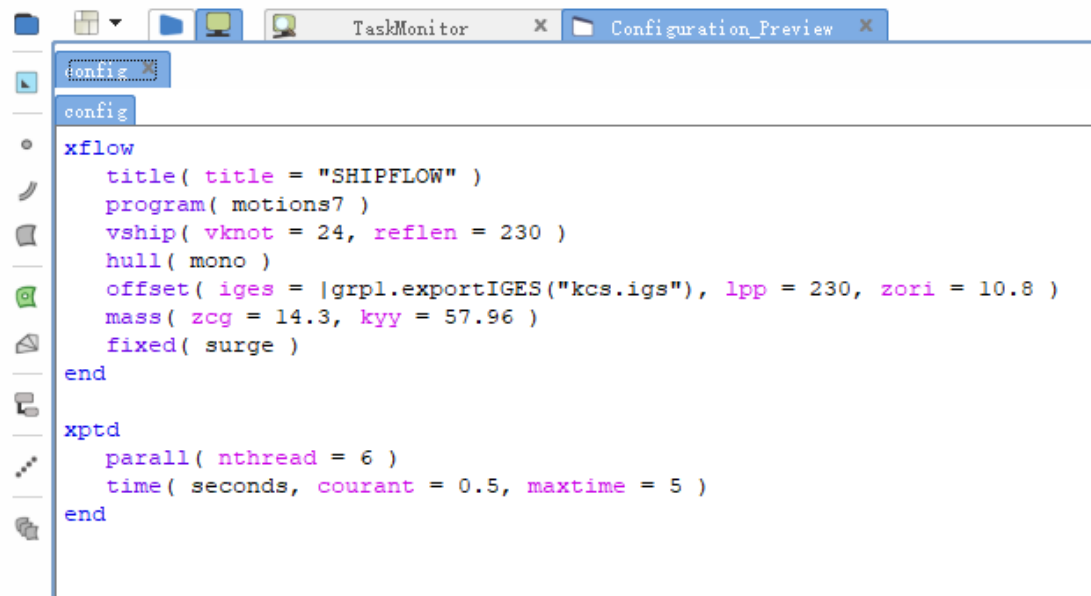
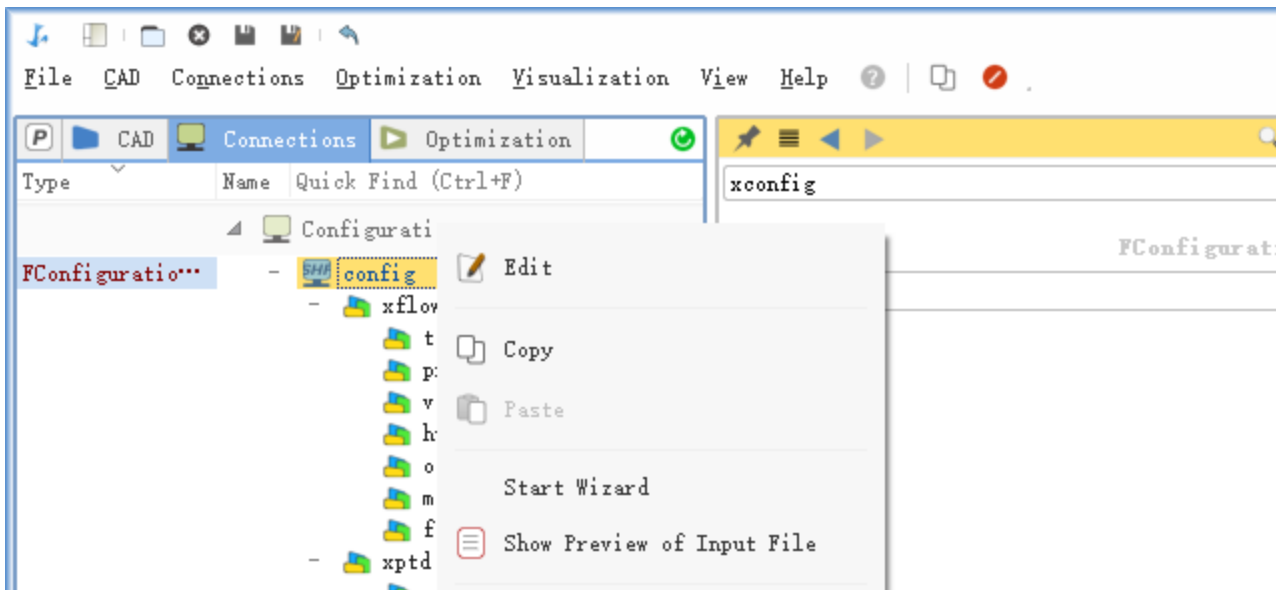
- 点击config>>xptd，下拉菜单中选择time
- 点击config>>xptd>>time，下拉菜单中选择unit, courant, maxtime
- 自行设置最大计算时间，默认最大计算时间是航行10倍船长





静水阻力计算设置—设置预览

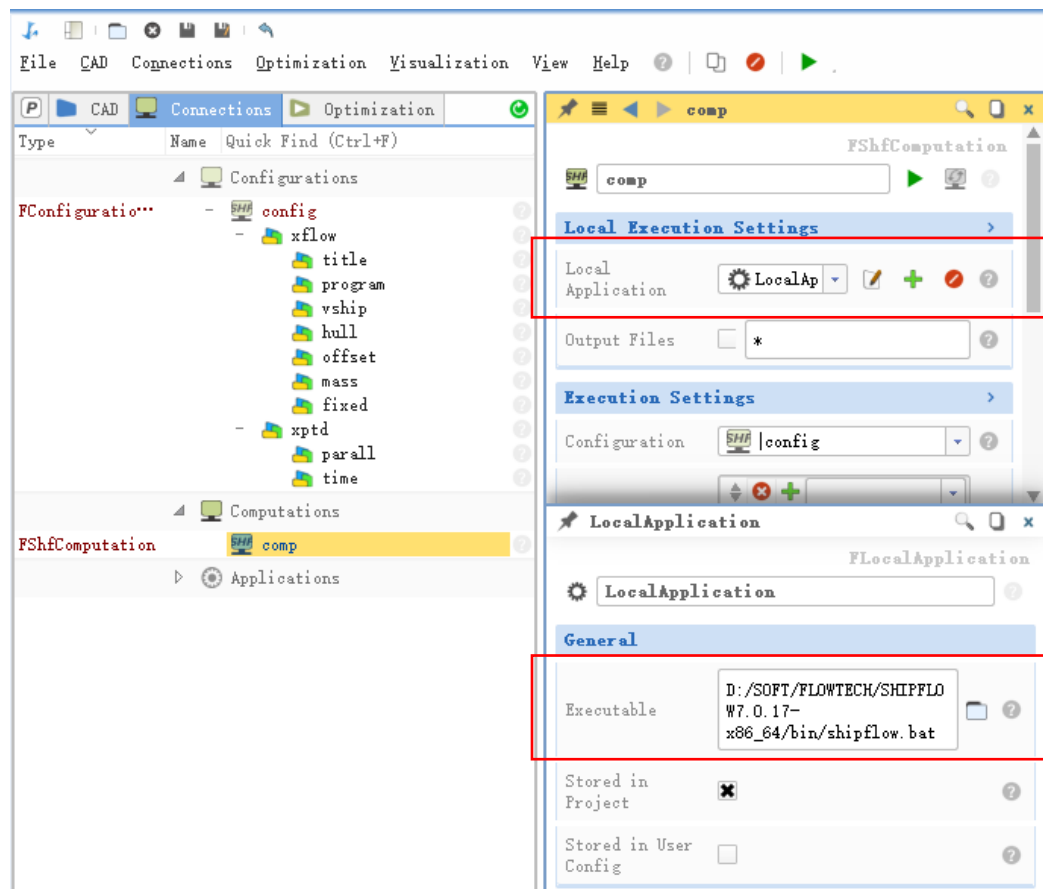
- 点击config，右键选择Show Preview of Input File，对完成的设置进行计算前的预览和检查





静水阻力求解

- 点击comp, LocalApplication默认添加求解器程序shipflow.bat的路径
- 如果是通过CAESES接口进行计算的情况, 需要点击LocalApplication后面的绿色加号, 然后指定shipflow.bat程序的路径
- 保存文件
- 点击绿色箭头开始计算



静水阻力求解—运行监控

- 点击TaskMonitor
- 点击shipflow.bat查看运行监控

The screenshot displays a software interface for simulation monitoring. On the left, a tree view shows configurations and computations. The middle pane shows the 'Local Execution Settings' for a computation named 'comp', with 'LocalAp' selected as the application. The bottom pane shows the 'LocalApplication' details, including the executable path 'D:/SOFT/FLOWTECH/SHIPFLO/W7.0.17-x86_64/bin/shipflow.bat'. The right pane shows the 'TaskMonitor' window with a table of simulation tasks and their performance metrics.

Name	Host / State	Started	Finished
unnamed.j14480			
P T0525			
v baseline			
v comp	local		
shipflow.bat	running	2023/...	

Elapsed simulation time [s] : 0.175
Iteration wall-clock time [s] : 1.667

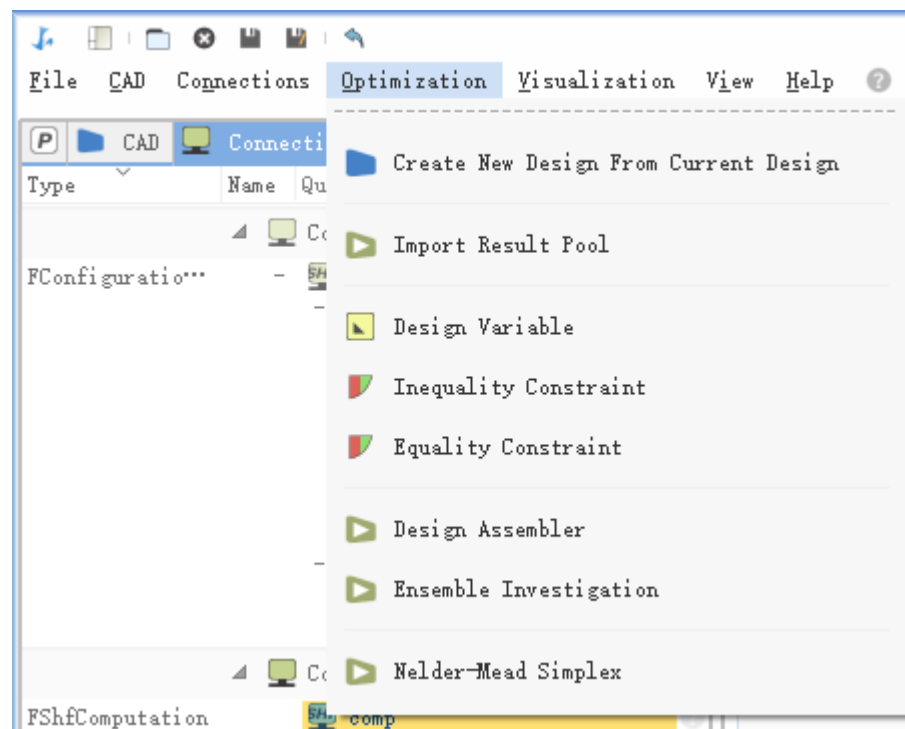
Beginning time step number : 4
Time step size [-] : 0.0120
Time step size [s] : 0.0582
Transom ID : 1
- Emerged
- Clearance factor : 1.000
Total number of active panels : 3420
- Free surface : 821
- Body surface : 2599
Distance sailed [m] : 0.004
Current speed [m/s] : 0.053
Current speed [kn] : 0.103
Current speed [Fn] : 0.001

Elapsed simulation time [s] : 0.233
Iteration wall-clock time [s] : 1.706



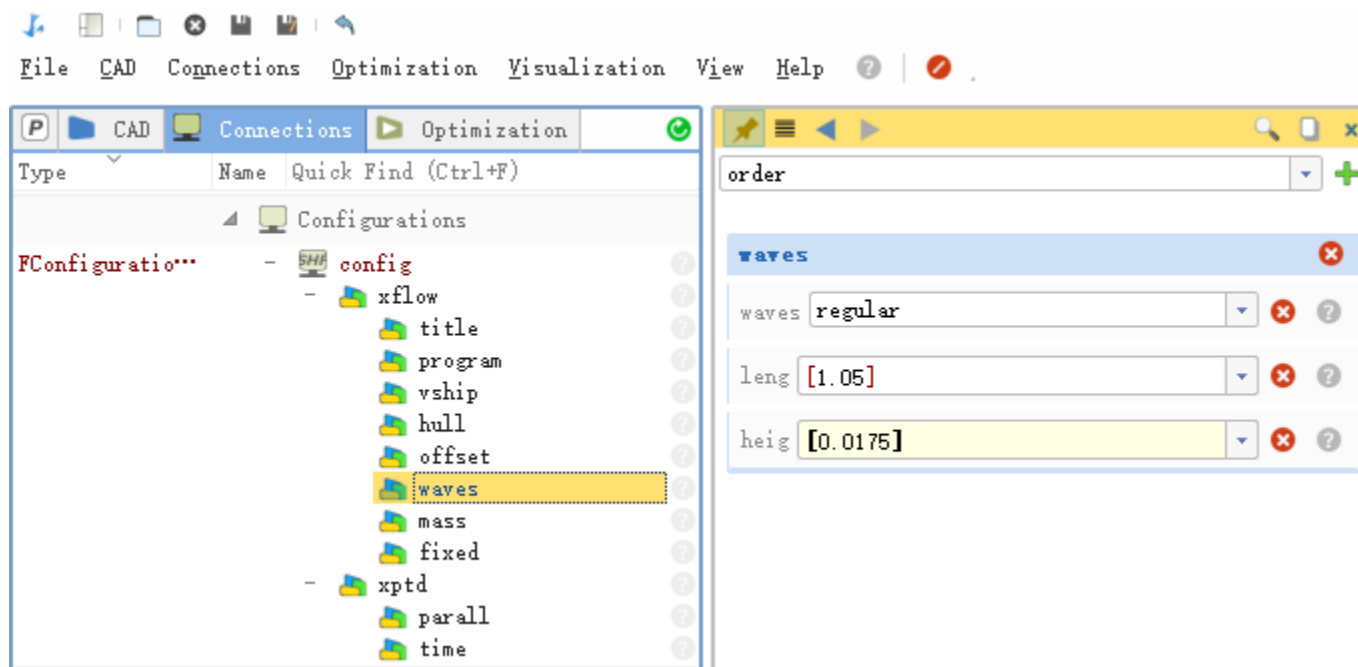
规则波阻力计算设置—新建设置

- 点击Optimization
- 点击Create New Design From Current Design新建设置



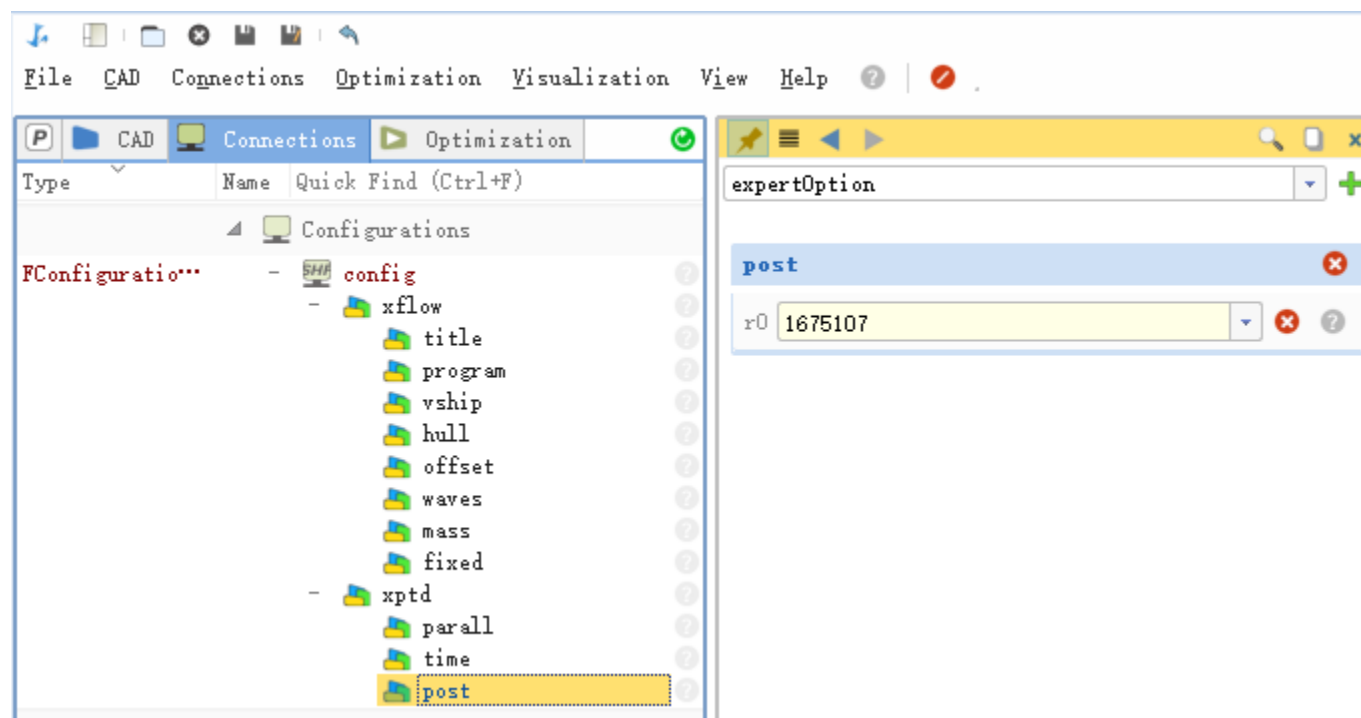
规则波阻力计算设置—波浪设置

- 点击xflow, 下拉菜单中选择waves
- 点击xflow>>waves, 下拉菜单中选择waves, waves选项菜单中选择regular
- 点击xflow>>waves, 下拉菜单中选择leng, 输入1.05, 设置规则波的波长, 此处数值为Lpp的倍数
- 点击xflow>>waves, 下拉菜单中选择heig, 输入0.0175, 设置规则波的波高, 此处数值为Lpp的倍数



规则波阻力计算设置—静水阻力结果输入

- 点击xptd，下拉菜单中选择post
- 点击xptd>>post，下拉菜单中选择r0，输入静水阻力数值





规则波阻力计算设置—设置预览

- 点击config，右键选择Show Preview of Input File，对完成的设置进行计算前的预览和检查

The screenshot shows a software interface with a file explorer on the left and a code editor on the right. The file explorer shows a tree view with 'config' selected, and a context menu is open over it, with 'Show Preview of Input File' highlighted. The code editor displays the following configuration file content:

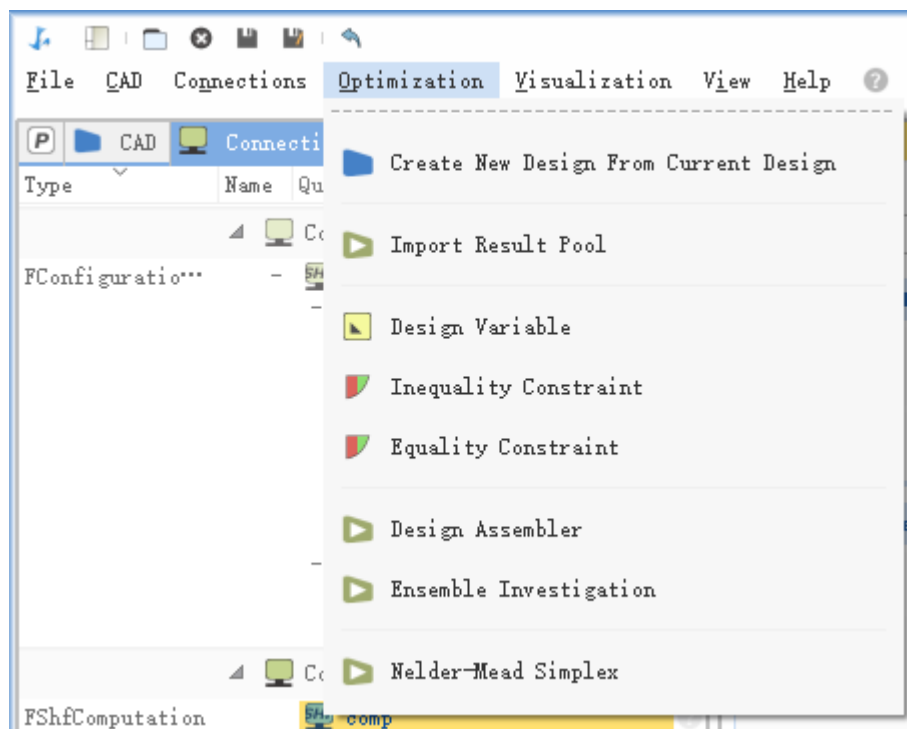
```
C:/Users/chenjunzhe/Desktop/T0525.fdb*

config x
config
xflow
  title( title = "SHIPFLOW" )
  program( motions7 )
  vship( vknot = 24, reflen = 230 )
  hull( mono )
  offset( iges = |grpl.exportIGES("kcs.igs"), lpp = 230, zori = 10.8 )
  waves( regular, leng = [1.05], heig = [0.0175] )
  mass( zcg = 14.3, kyy = 57.96 )
  fixed( surge )
end
xptd
  parall( nthread = 6 )
  time( seconds, courant = 0.5, maxtime = 10 )
  post( r0 = 1675107 )
end
```



不规则波阻力计算设置—新建设置

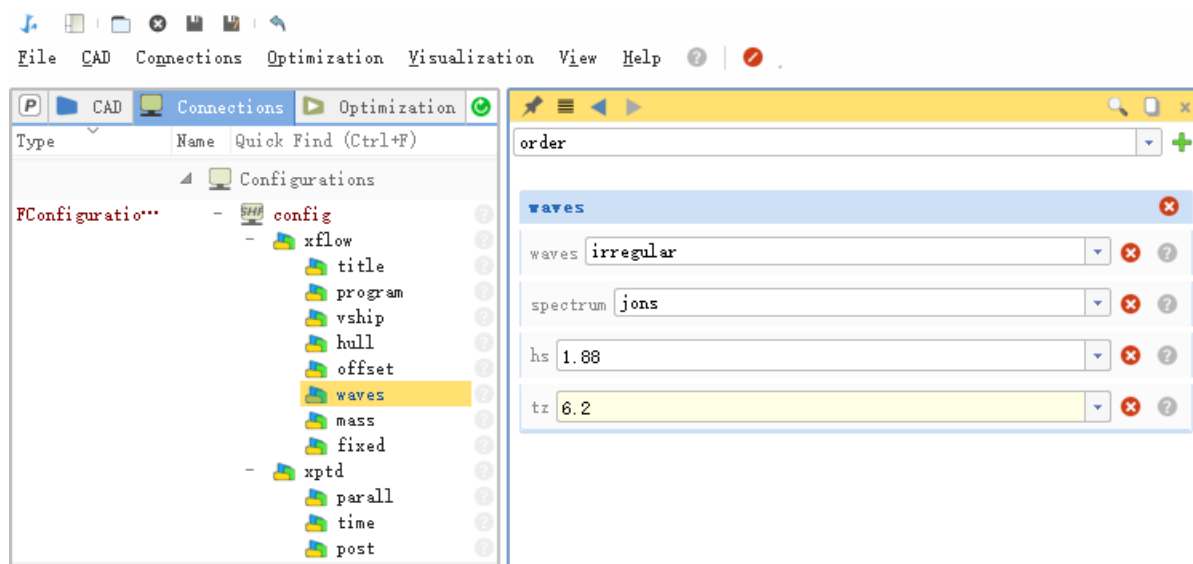
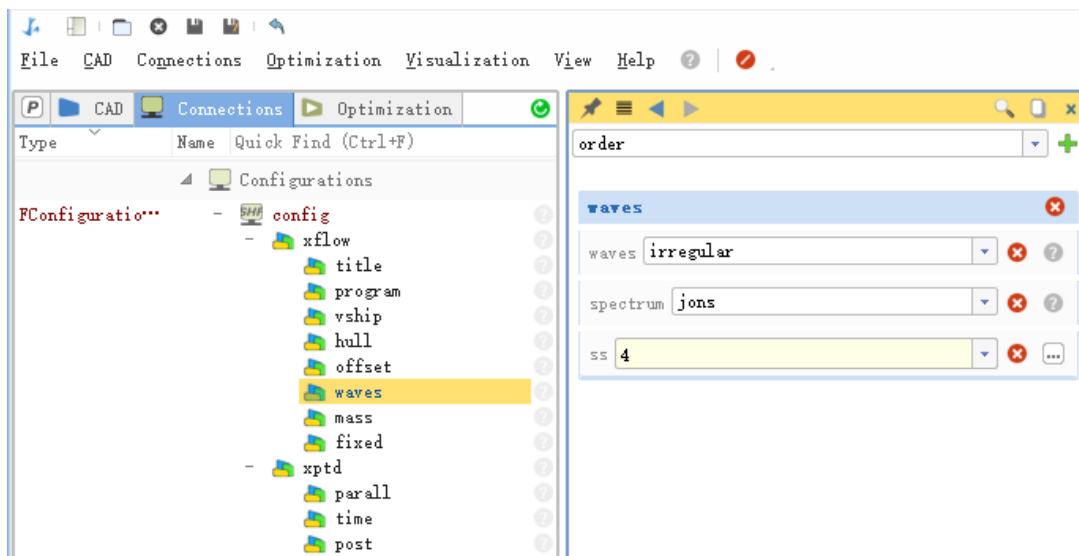
- 点击Optimization
- 点击Create New Design From Current Design新建设置





不规则波阻力计算设置—波浪设置

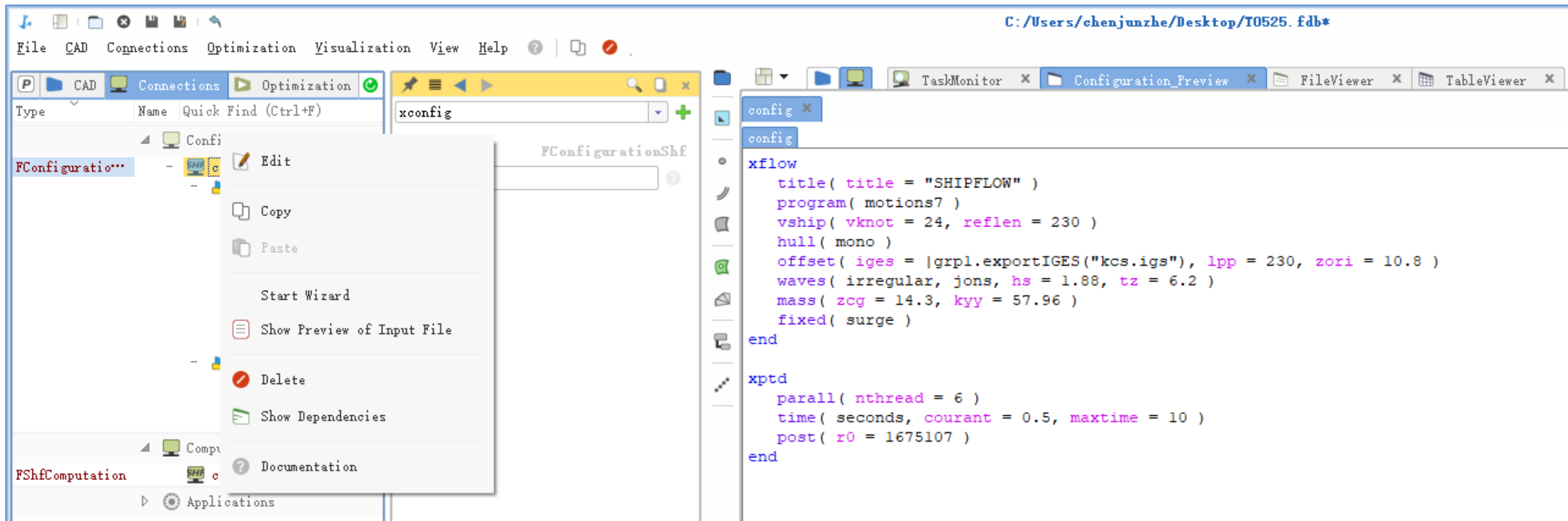
- 点击xflow>>waves, 删除leng和heig
- 点击xflow>>waves, waves选项菜单中选择irregular
- 点击xflow>>waves, 下拉菜单中选择spectrum, spectrum选项菜单中自行选择波谱
- 点击xflow>>waves, 下拉菜单中选择ss, 自行输入海况等级, 范围2~8级; 或者选择hs和tz分别指定有义波高和跨零周期





不规则波阻力计算设置—设置预览

- 点击config，右键选择Show Preview of Input File，对完成的设置进行计算前的预览和检查





波浪增阻计算流程

1. 求解静水阻力 RT_{calm}
2. 求解规则波/不规则波阻力 RT
3. 计算波浪增阻 RAW ，如果在求解波浪阻力的设置中添加了静水阻力，则软件自动计算 RAW ，否则需要手动相减

$$RAW = RT - RT_{calm}$$

$$CAW = RAW / (\rho * g * B^2 * H^2 / L_{pp})$$

or

$$CAW = RAW / (\rho * g * B^2 * A^2 / L_{pp})$$

where:

ρ - water density [kg/m³],

g - gravitational acceleration (9.81 [m/s²]),

B - Beam [m],

H - Wave height [m],

A - Wave amplitude [m],



计算结果查看

- 点击TableViewer, 查看计算结果列表, 包含阻力数据和运动数据
- 点击FileViewer>>config_OUTPUT, 查看完整的输出文件, 内容包括输入参数、默认参数和计算结果

Parameter	Value
0	0
LPP	230
B	32.431
V	51925.5
S	9679.88
m	5.32766e+07
LCO%	-1.503
XCG	111.543
YCG	0
ZCG	14.3
KXX	11.351
KYY	57.96
KZZ	57.5
KXY	0
KXZ	0
KYZ	0
IXX	6.86426e+09
IYY	1.78976e+11
IZZ	1.76146e+11
IXY	0
IXZ	0
IYZ	0
RA01	0
RA02	0
RA03	0.692
RA04	0
RA05	0.539
RA06	0
PHASE1	145.345
PHASE2	-124.792
PHASE3	-37.677
PHASE4	-124.792
PHASE5	-177.175
PHASE6	-124.792
RW_std	0.062
RT	3.34013e+06
RW	2.03645e+06
RF	1.30368e+06
RT_AP	3.29757e+06
RW_AP	1.99389e+06
RO	1.67511e+06
RAW	1.66503e+06
CAW	8.935
CF*1000	1.378
k	0.25

```
stdouterroroutput.redirect config config_OUTPUT
Yaw 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
Wave -4.38790E-03 2.00273E+00 5.26778E-02 2.10756E-03 7.00985E-05 2.53736E-05

Phase angles of the harmonic amplitudes (in degrees relative the incident wave at CG)
-----
Phase1 Phase2 Phase3 Phase4 Phase5
Surge 145.345 20.531 -102.942 131.711 -44.709
Sway -124.792 110.615 -12.637 -137.763 46.397
Heave -37.677 -62.111 -10.495 -29.921 -176.720
Roll -124.792 110.615 -12.637 -137.763 46.397
Pitch -177.175 108.699 -158.283 152.780 -3.364
Yaw -124.792 110.615 -12.637 -137.763 46.397
-----

RESISTANCE SUMMARY
-----

Definitions of resistance components
-----
RT = RW + RF : Total resistance
RW : Wave resistance from pressure integration
RF = RFO * (1 + k) : Friction resistance
RFO = 1/2 * rho * Vs^2 * S * CF : Flat plate skin friction
RO : Calm water reference resistance
RAW = RT - RO : Added resistance

NOTE: RO and RAW are only available if calm water resistance RO is given as input in XPTD:POST:RO = v

NOTE: The suffix "_AP" below denotes the use of acceleration potential when computing the dynamic pressure.
These components are typically less accurate and should not be considered for normal use.

RW_std (Standard deviation of RW [%]) : 0.062
RT (Total resistance [N]) : 3340132.206
RW (Wave resistance [N]) : 2036450.578
RF (Friction resistance [N]) : 1303681.628

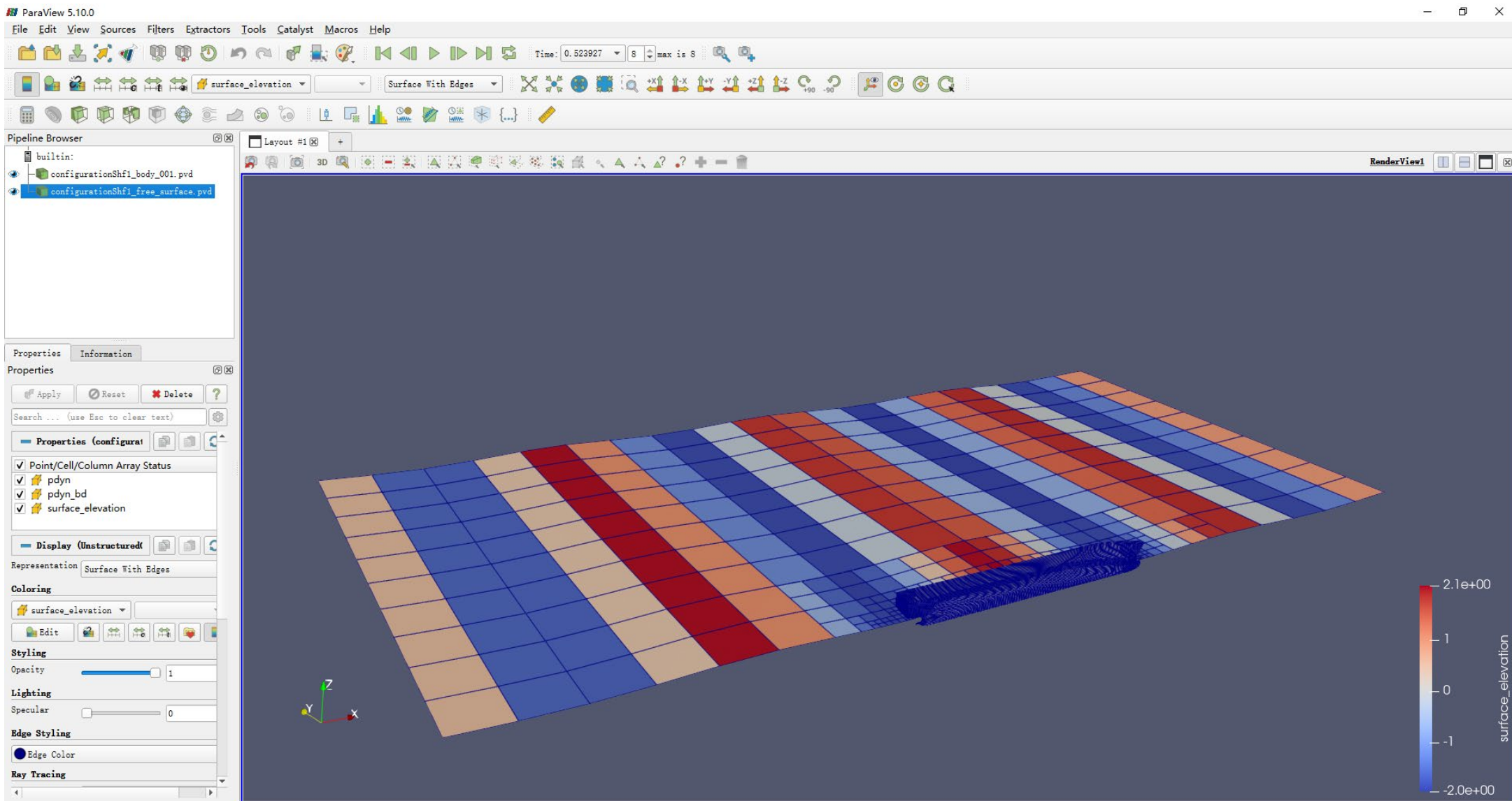
RT_AP (Total resistance [N]) : 3297572.547
RW_AP (Wave resistance [N]) : 1993890.919

RO (Calm water resistance [N]) : 1675107.000
RAW (Added resistance [N]) : 1665025.206
CAW (Added resistance coefficient [-]) : 8.935

S (Wetted surface area [m^2]) : 9679.883
CF*1000 (Friction resistance coefficient [-]) : 1.378
k (Form factor [-]) : 0.250
```



后处理—动画播放



02

特殊船型IGES模型波浪增阻与运动计算方法



计算方法选择说明

特殊船型计算方法适用于软件不能正常将导入的IGES模型转换为Offset模型的情况，通常情况下，推荐使用常规船型的计算方法

常规船型：

- 集装箱
- 散货
- 油船

特殊船型：

- 单体+特殊附体
- 双体
- 三体
- 潜器和其他



静水阻力计算设置

```
TaskMonitor x | fileViewer1 x | tableViewer1 x | Configuration_Preview x
configurationShf1 x | :onfigurationShf' x | configurationShf1 x |
:onfigurationShf'
xflow
  title( title = "SHIPFLOW" )
  program( motions7 )
  vship( vknot = 24,reflen = 230 )
  hull( mono )
  offset( file = |SHF_Import_off_dummy|as_off_dummy.exportSHF("as_off_duy"),
lpp = 230,
          zori = 10.8 )
  mass( zcg = 14.3,kyy = 57.96 )
  fixed( surge )
end

xmtd
  import( file = "C:\Users\chenjunzhe\Desktop\kcs\_hull.obj" )
  import( file = "C:\Users\chenjunzhe\Desktop\kcs\_transom.obj",tran )
end

xptd
  parall( nthread = 6 )
end
```

通过Rhino软件分别生成船体和尾封板网格，然后导入网格进行计算



规则波阻力计算设置

```
TaskMonitor x | fileViewer1 x | tableViewer1 x | Configuration_Preview x
configurationShf1 x | :onfigurationShf' x | configurationShf1 x
:onfigurationShf'
xflow
  title( title = "SHIPFLOW" )
  program( motions7 )
  vship( vknot = 24,reflen = 230 )
  hull( mono )
  offset( file = |SHF_Import_off_dummy|as_off_dummy.exportSHF("as_off_duy"),
lpp = 230,
          zori = 10.8 )
  waves( regular,leng = [1.05],heig = [0.0175] )
  mass( zcg = 14.3,kyy = 57.96 )
  fixed( surge )
end

xmtd
  import( file = "C:\Users\chenjunzhe\Desktop\kcs\_hull.obj" )
  import( file = "C:\Users\chenjunzhe\Desktop\kcs\_transom.obj",tran )
end

xptd
  parall( nthread = 6 )
end
```




不规则波阻力计算设置

```
TaskMonitor x | fileViewer1 x | tableViewer1 x | Configuration_Preview x
configurationShf1 x | configurationShf1 x | :onfigurationShf' x
:onfigurationShf'
xflow
  title( title = "SHIPFLOW" )
  program( motions7 )
  vship( vknot = 24,reflen = 230 )
  hull( mono )
  offset( file = |SHF_Import_off_dummy|as_off_dummy.exportSHF("as_off_duy"),
lpp = 230,
          zori = 10.8 )
  waves( irregular,jons,ss = 4 )
  mass( zcg = 14.3,kyy = 57.96 )
  fixed( surge )
end

xmtd
  import( file = "C:\Users\chenjunzhe\Desktop\kcs\_hull.obj" )
  import( file = "C:\Users\chenjunzhe\Desktop\kcs\_transom.obj",tran )
end

xptd
  parall( nthread = 6 )
end
```

谢谢观看！

天沕 - 智能工业设计软件全球引领者

