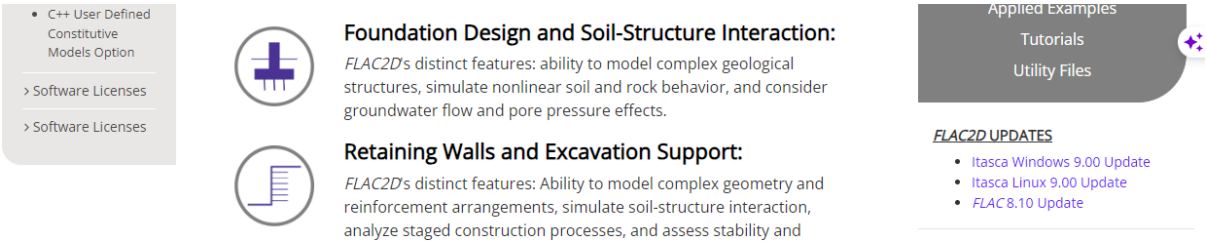
FLAC2D (Itasca C.G.)

From the website:

https://www.itascainternational.com/software/flac2d

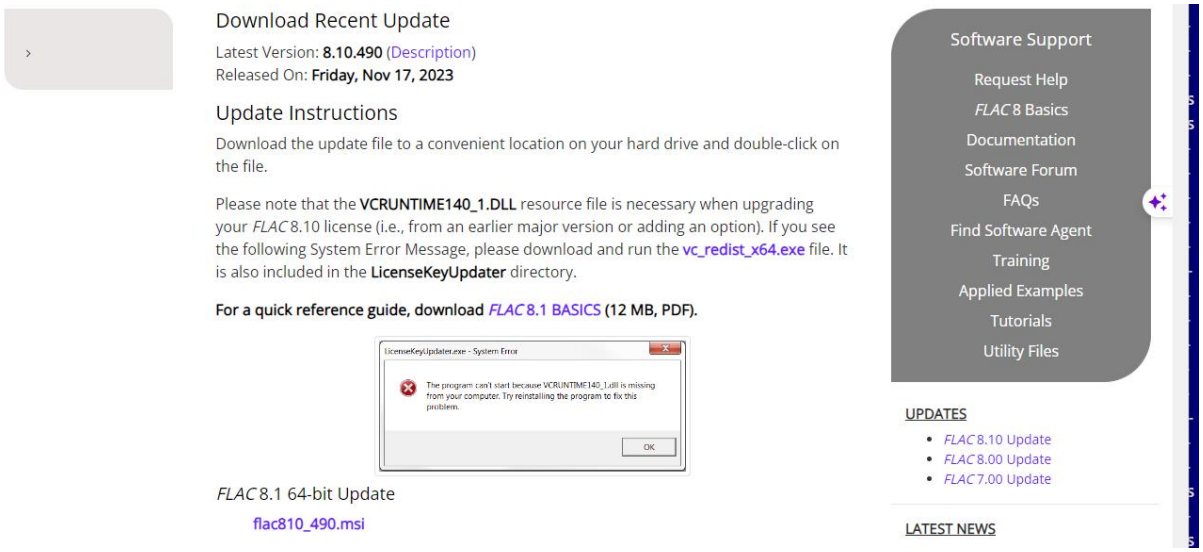


Please go to the website:

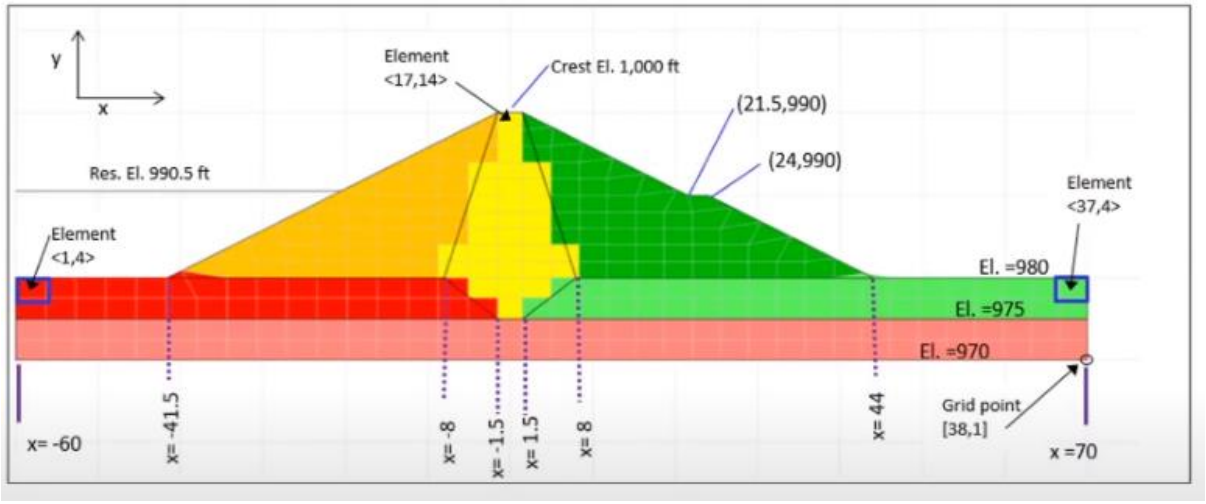
https://www.itascainternational.com/software/downloads/flac-8-10-update

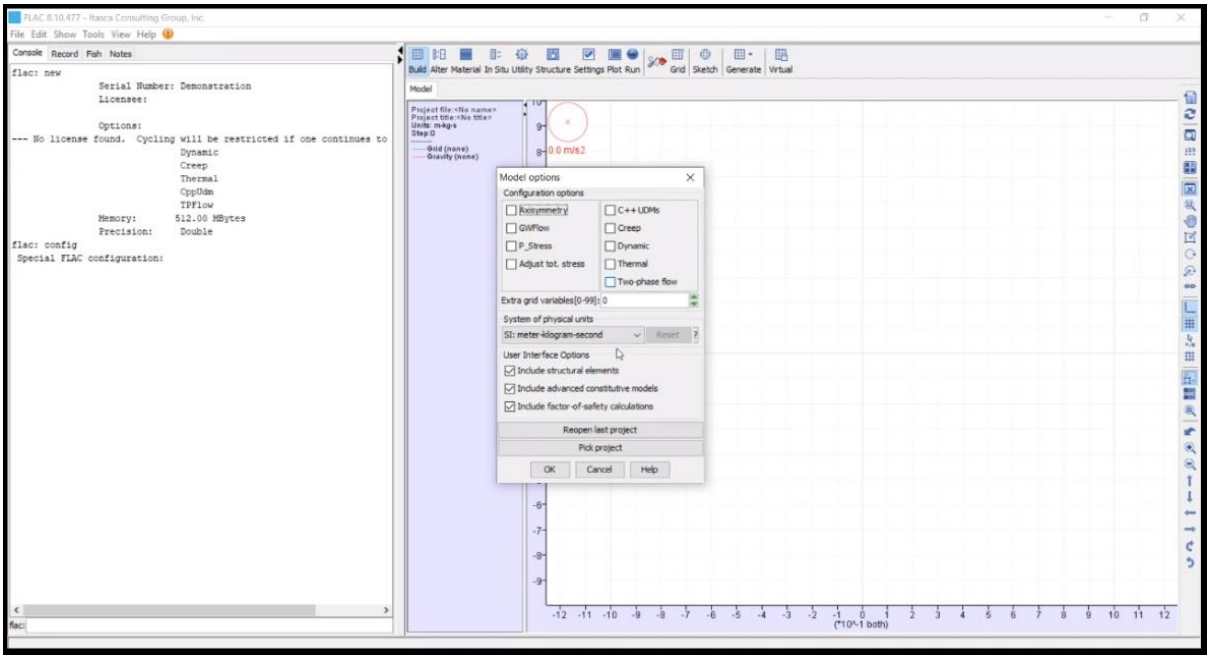
Please download and install the program “flac810_490.msi”.

and then run it (check if it starts).

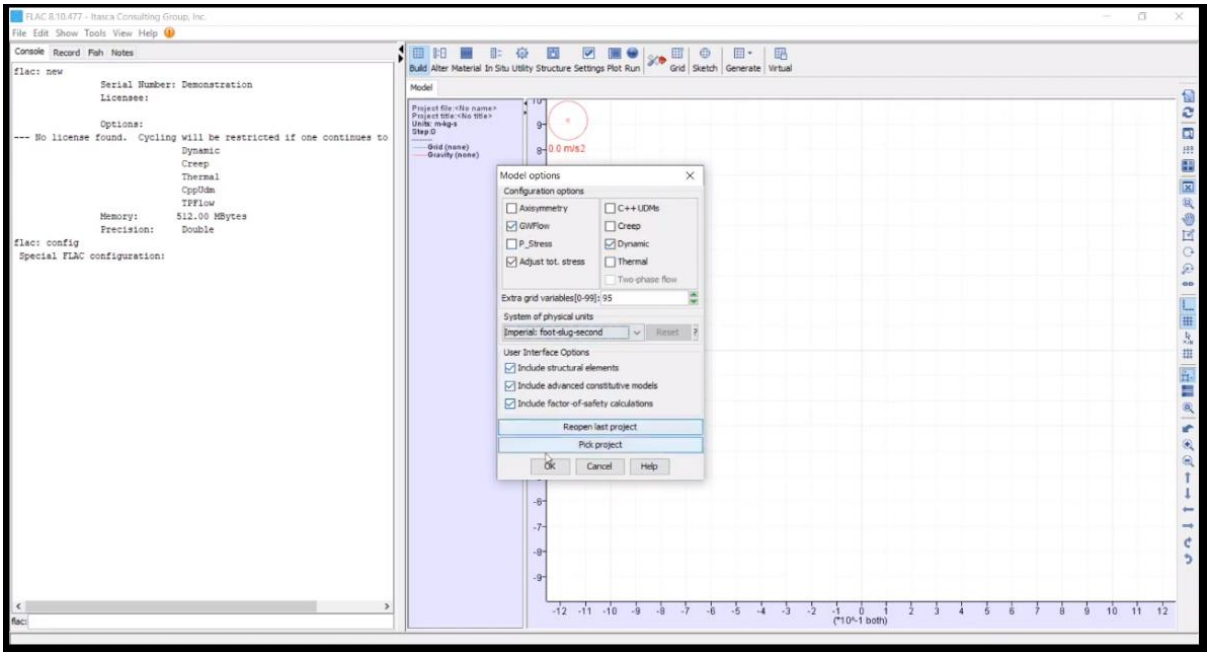


Based on Jensen N. (2021):



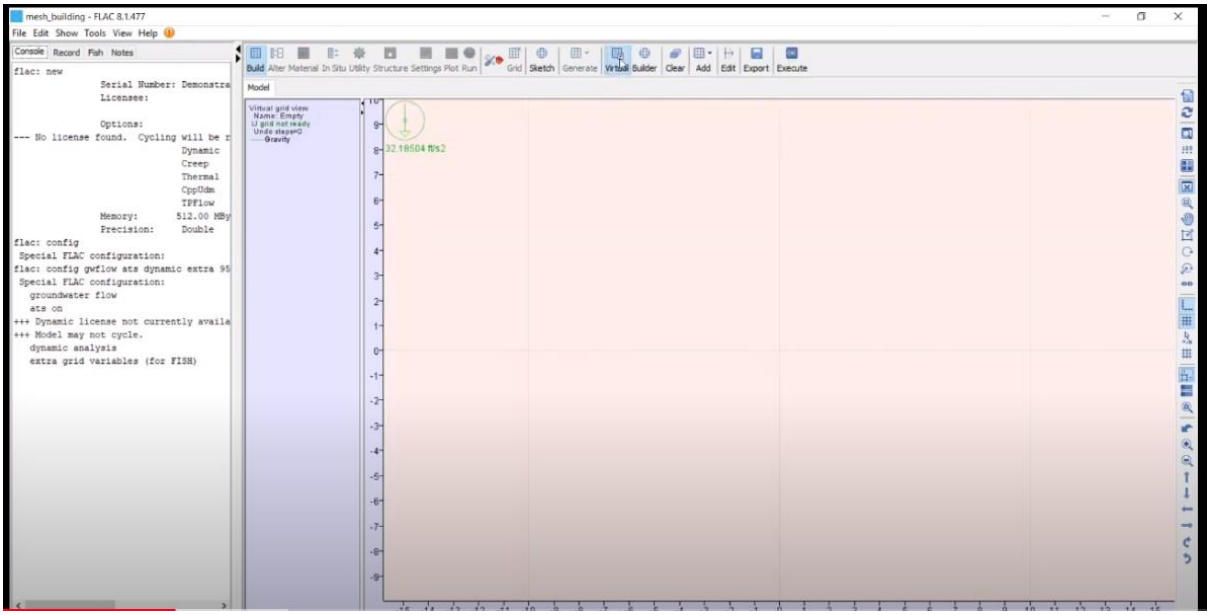


Imperial … -> SI !!!!!!!!!!

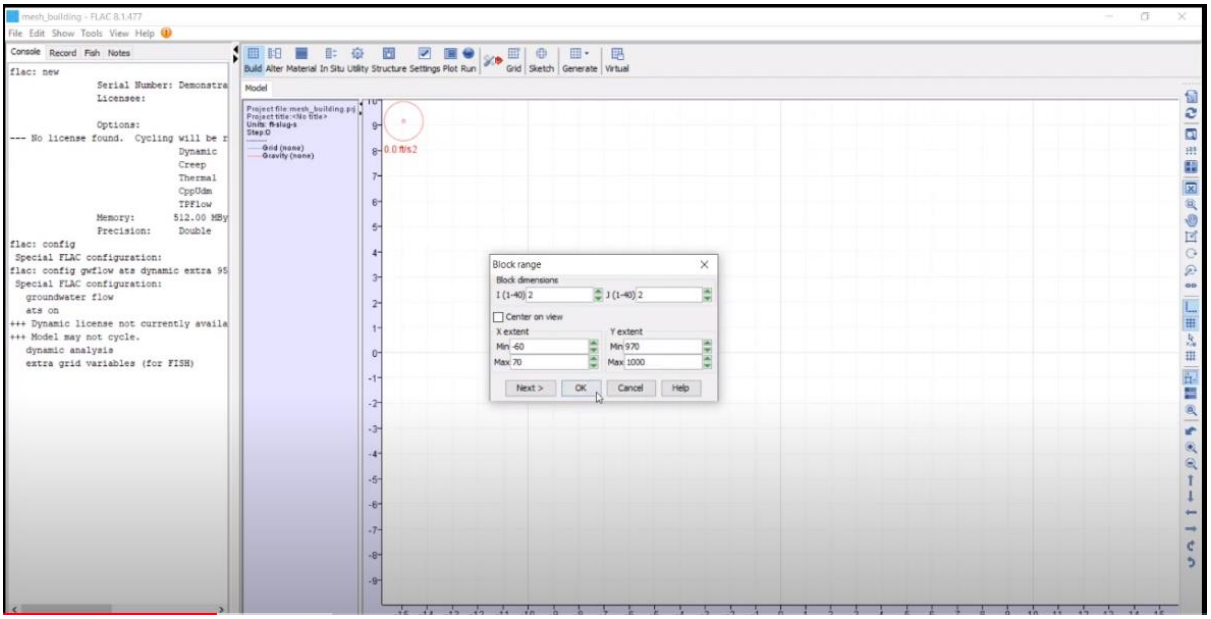


Save

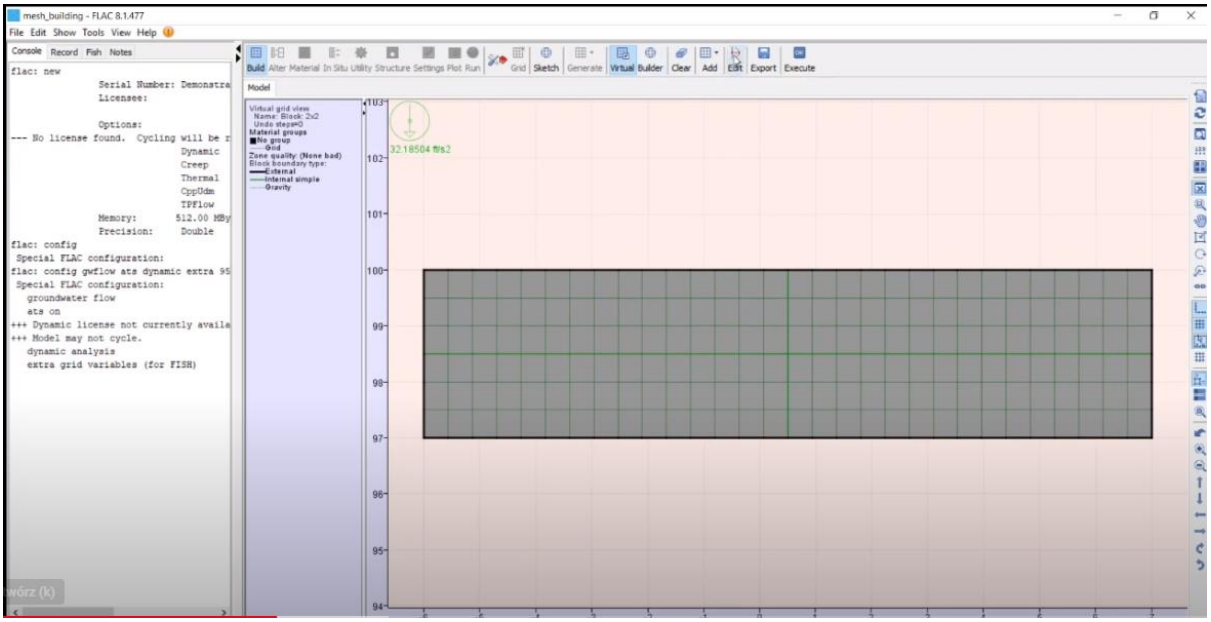
Generate -> Virtual -> Add Block



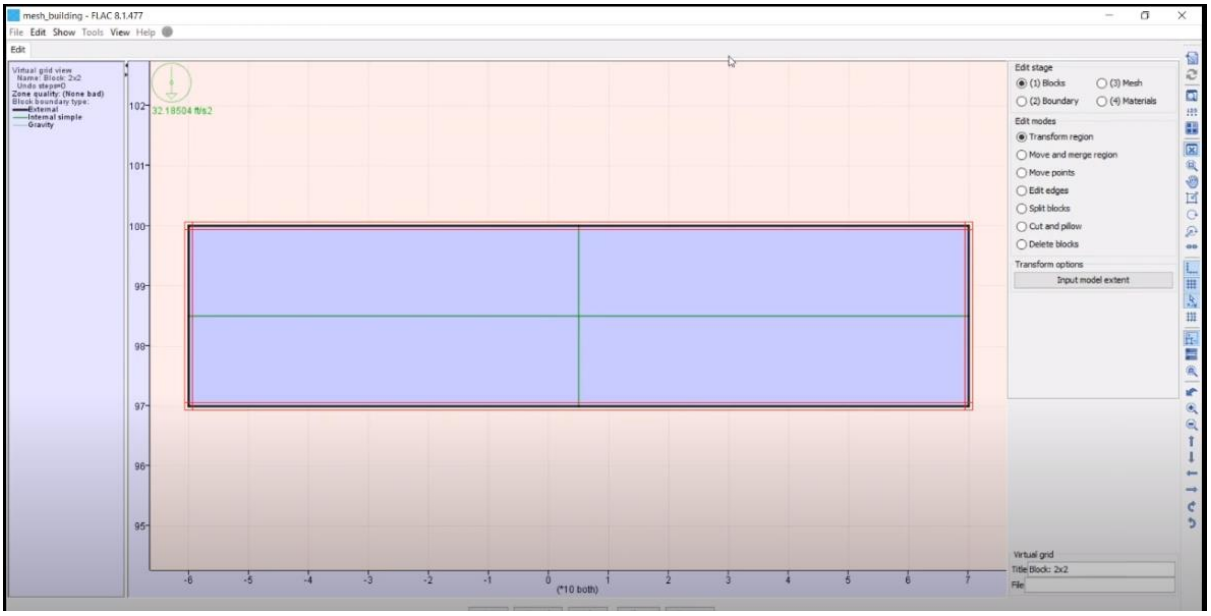
Generate –> Block



Coordinates -> On

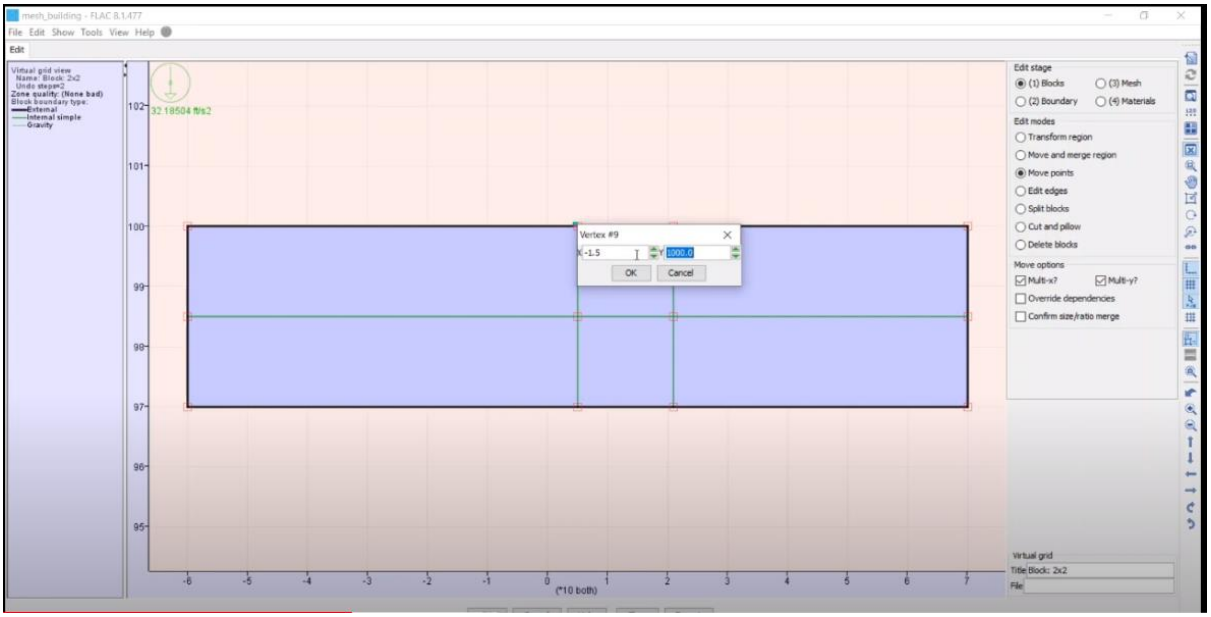


Virtual -> Edit



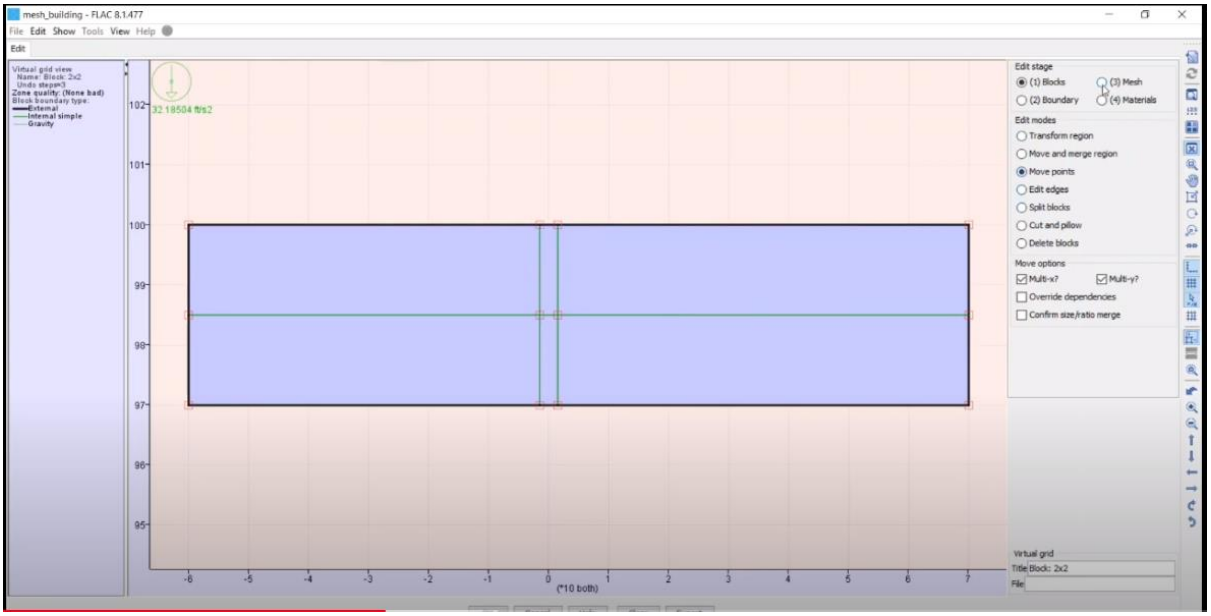
Blocks -> Move Points

Blocks -> Split blocks (then click on the upper right edge of the 2x10m coordinates)



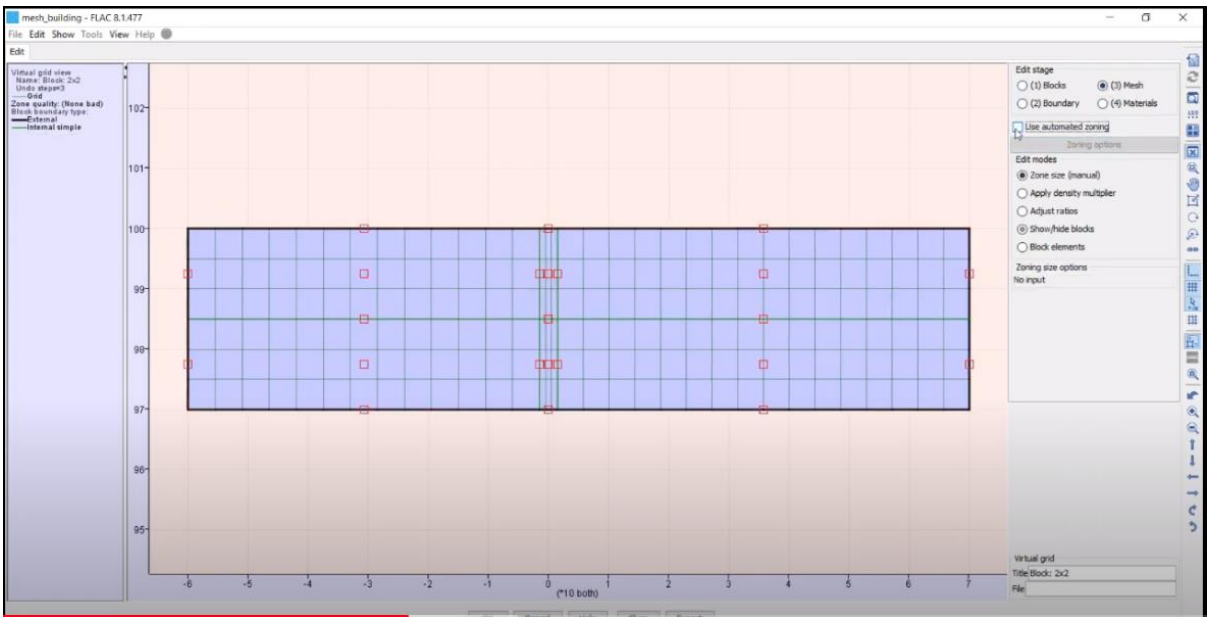
Move options

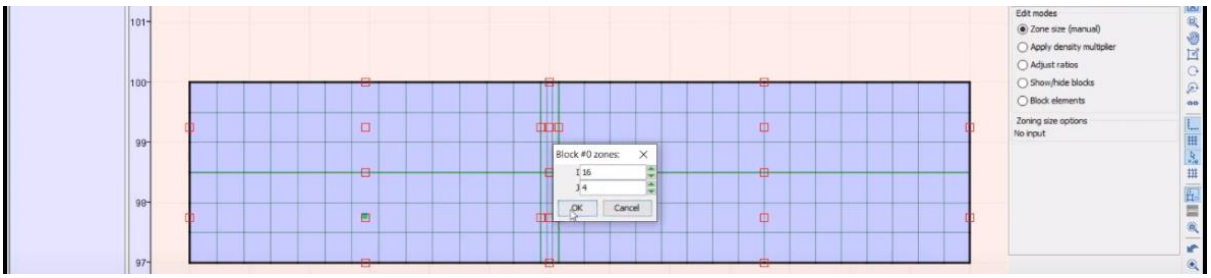
Move points (2nd point, 1.5, 1000)

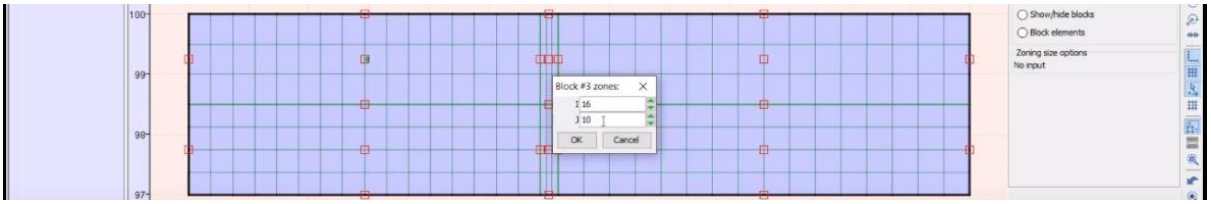


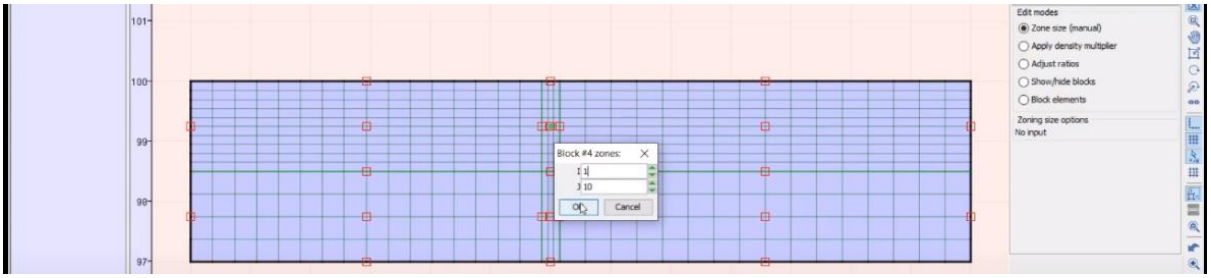
<u>Mesh</u>

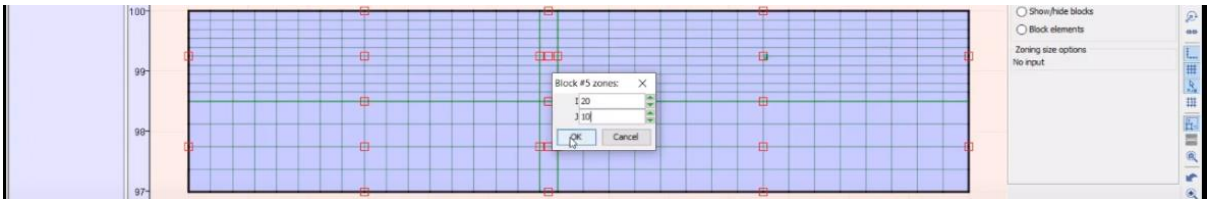
Use automated zoning off

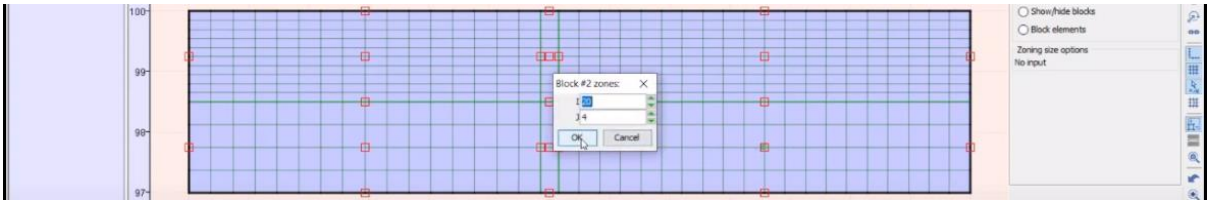






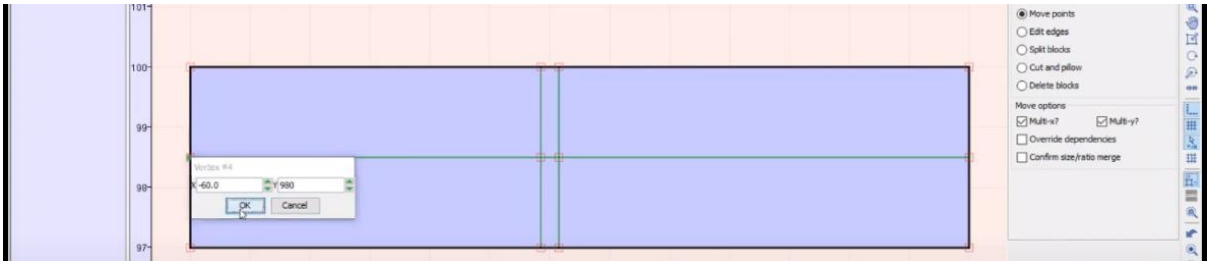




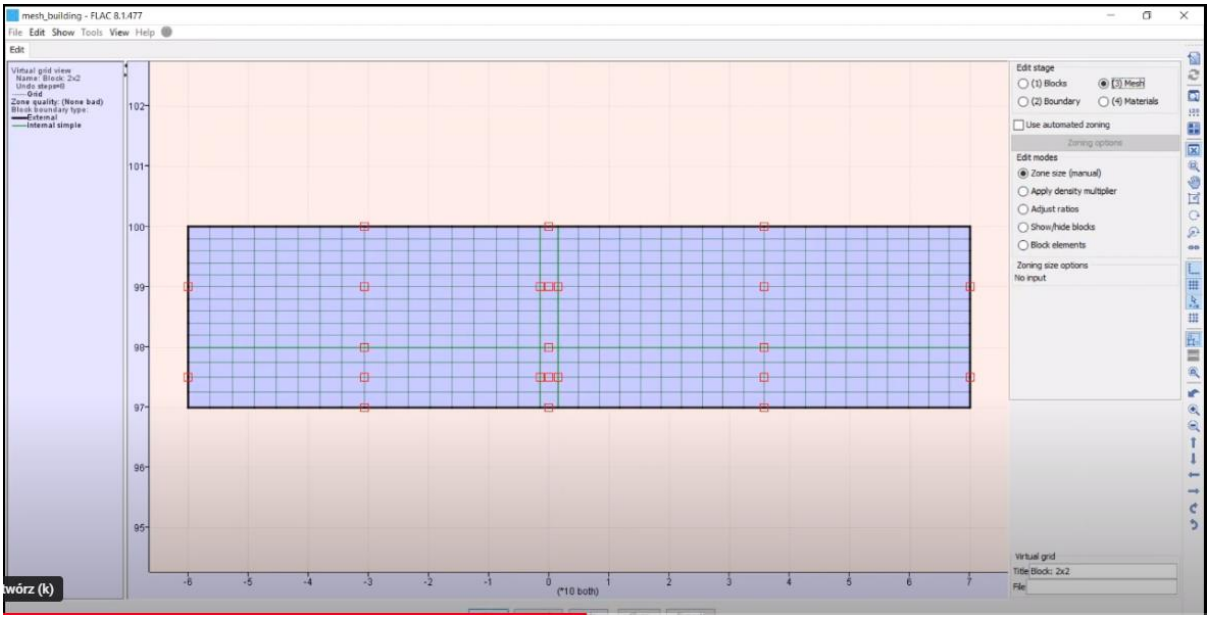


Blocks -> Move points

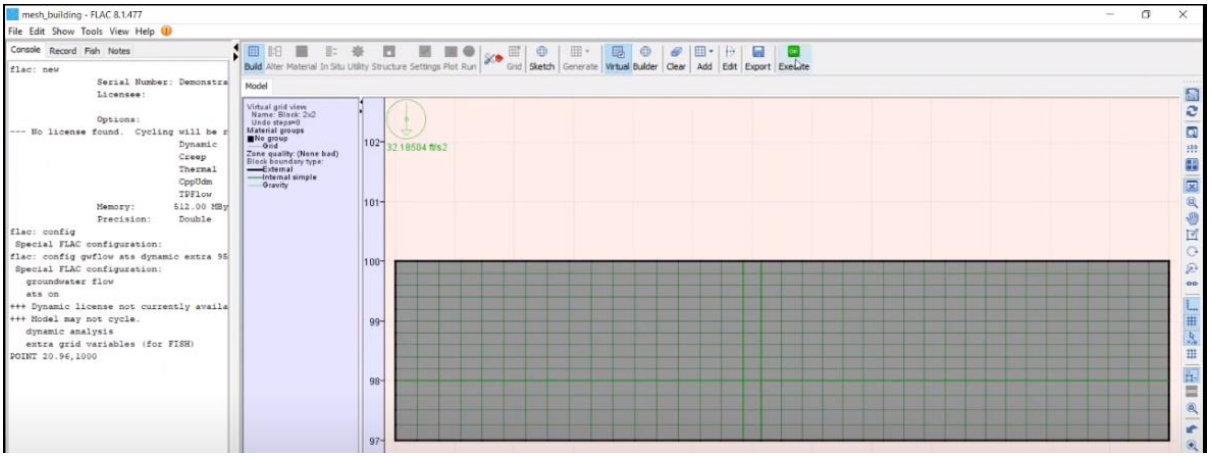
Changing the Y coordinates of the left edge



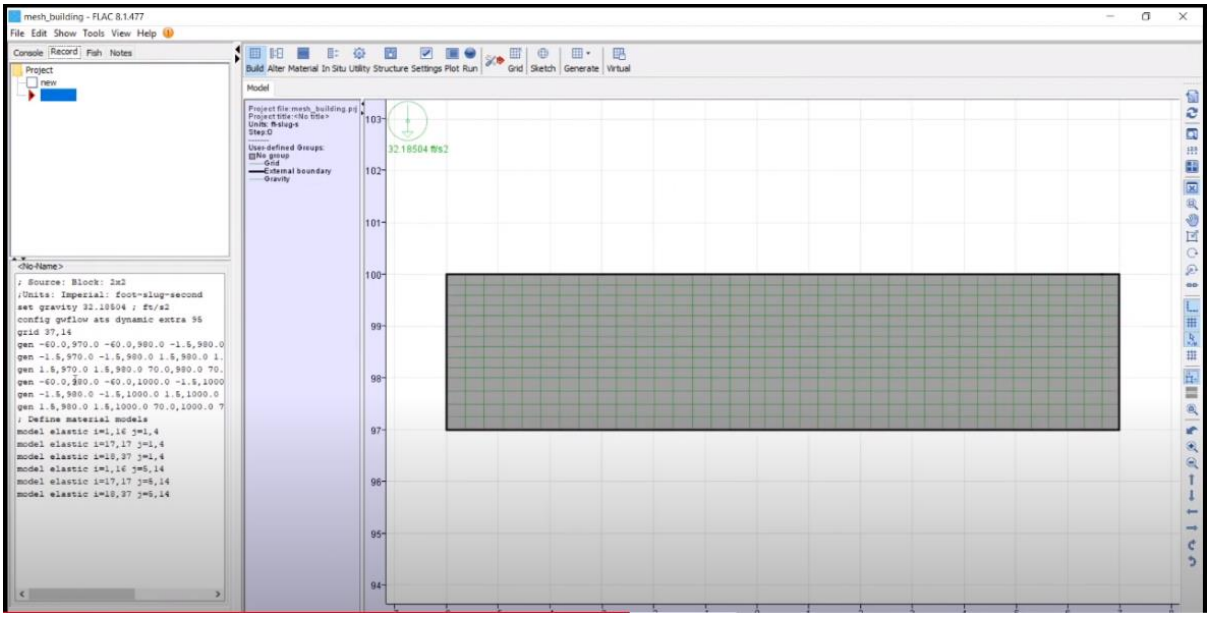
-> O.k.



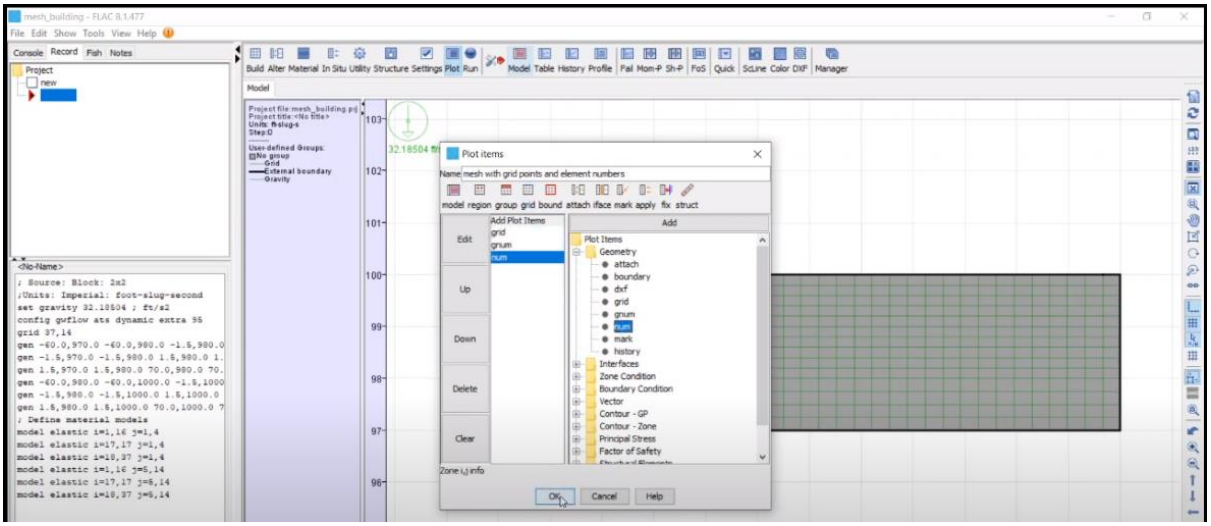
Execute

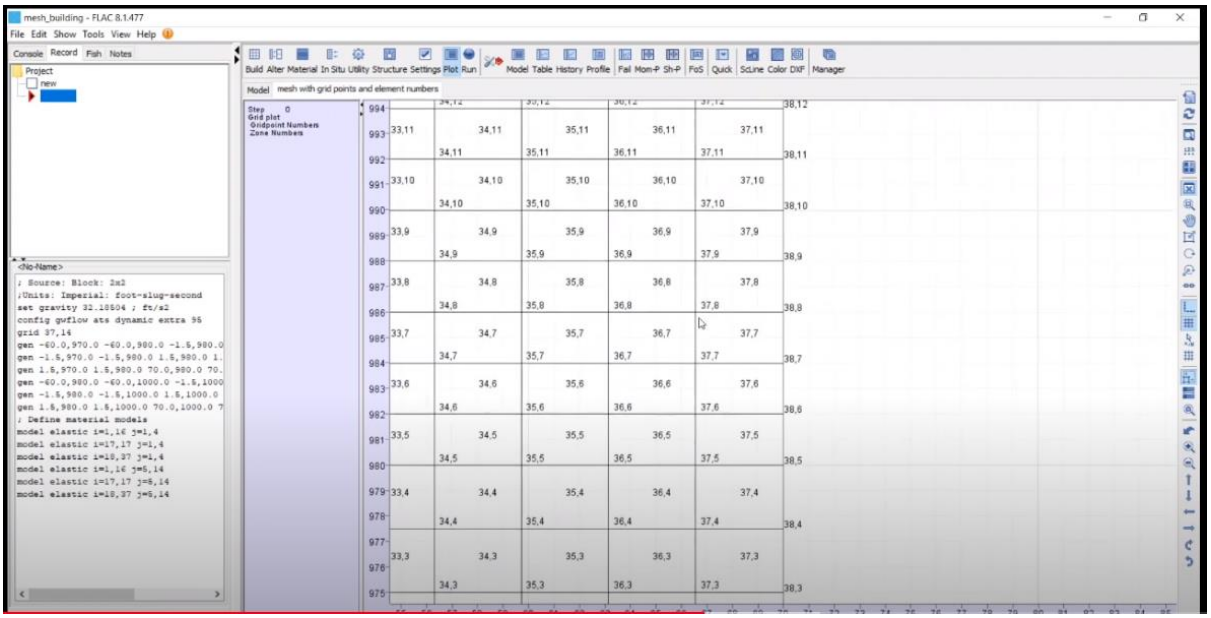


Record -> Execute

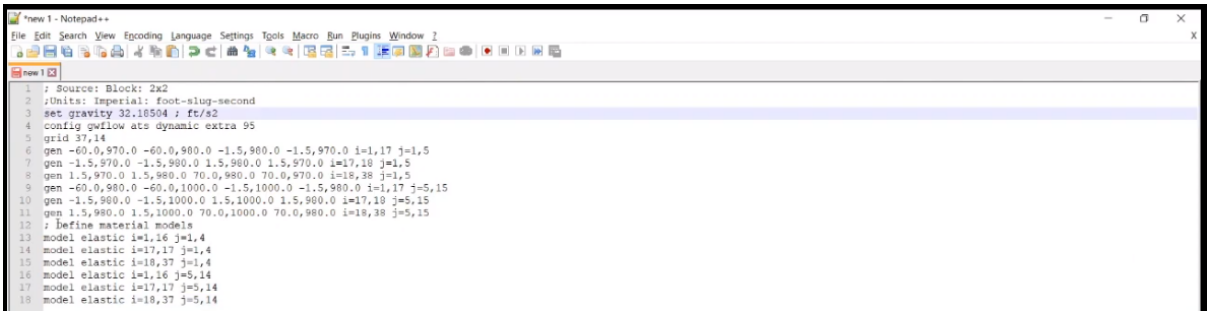


Plot -> Model -> Grid

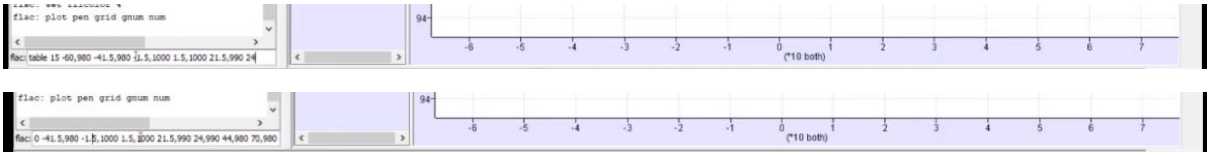




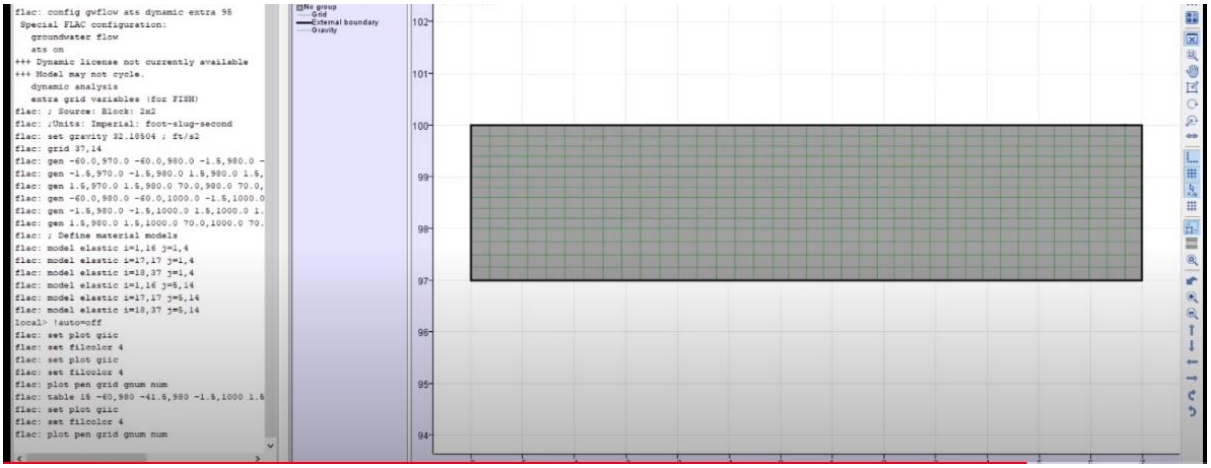
Copy text code to notepad



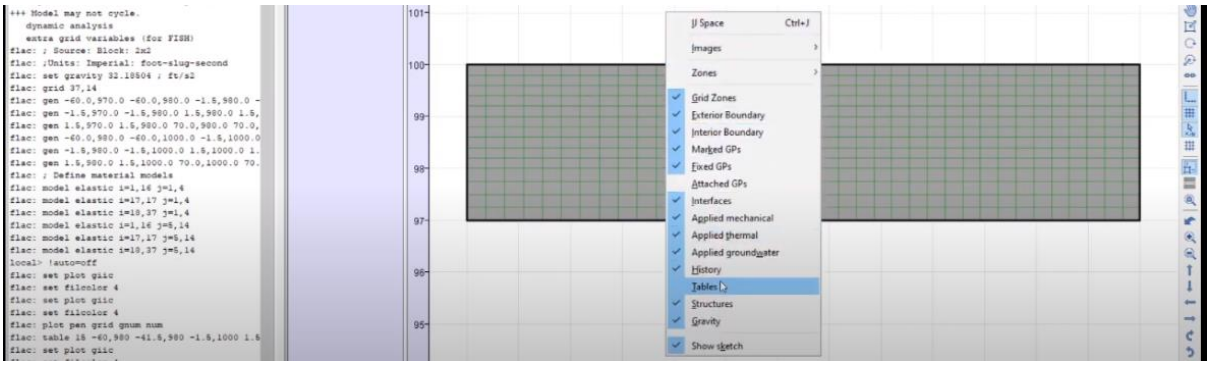
Console -> flac:

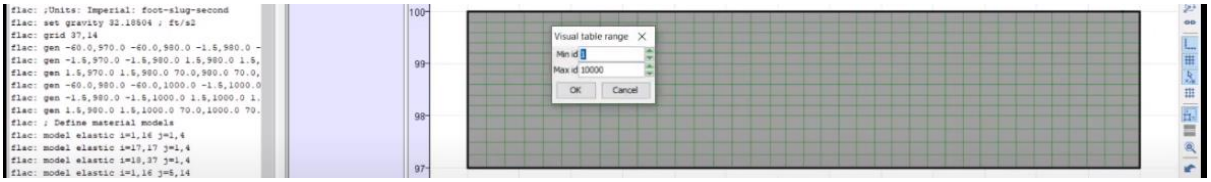


flac: table 15 -60,980 -41.5,980 -1.5,1000 21.5,990 24,990 44,980 70,980



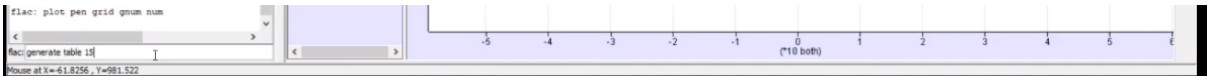
RMB -> Tables



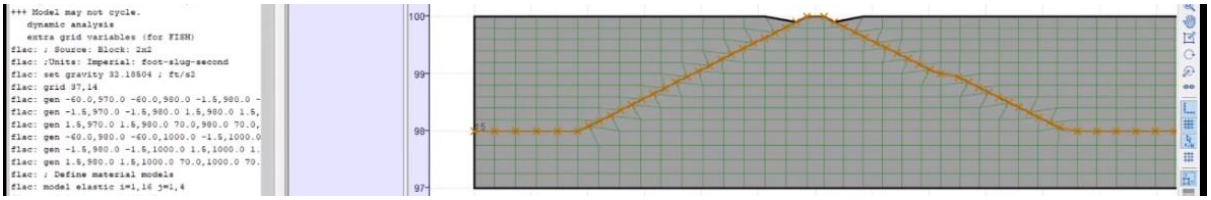


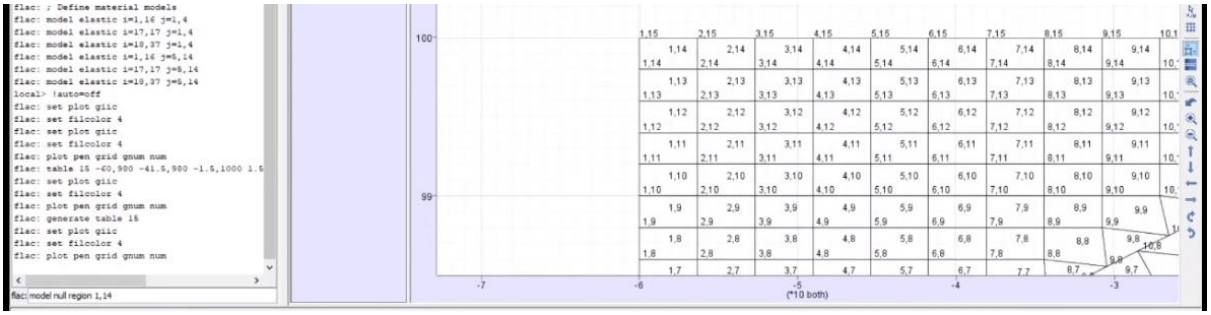
Refresh (top right icon, vertical bar)

Console -> flac: generate

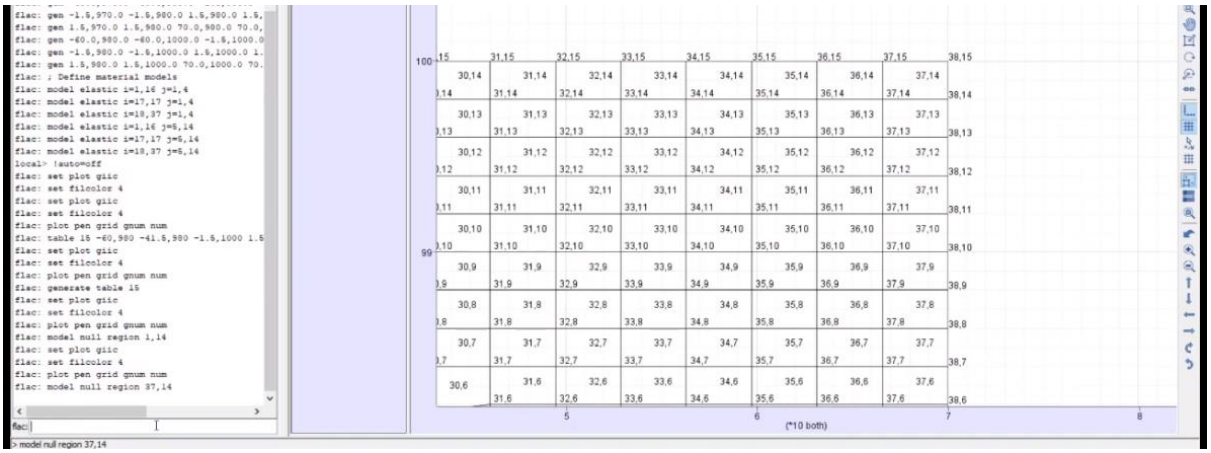


flac: generate table 15



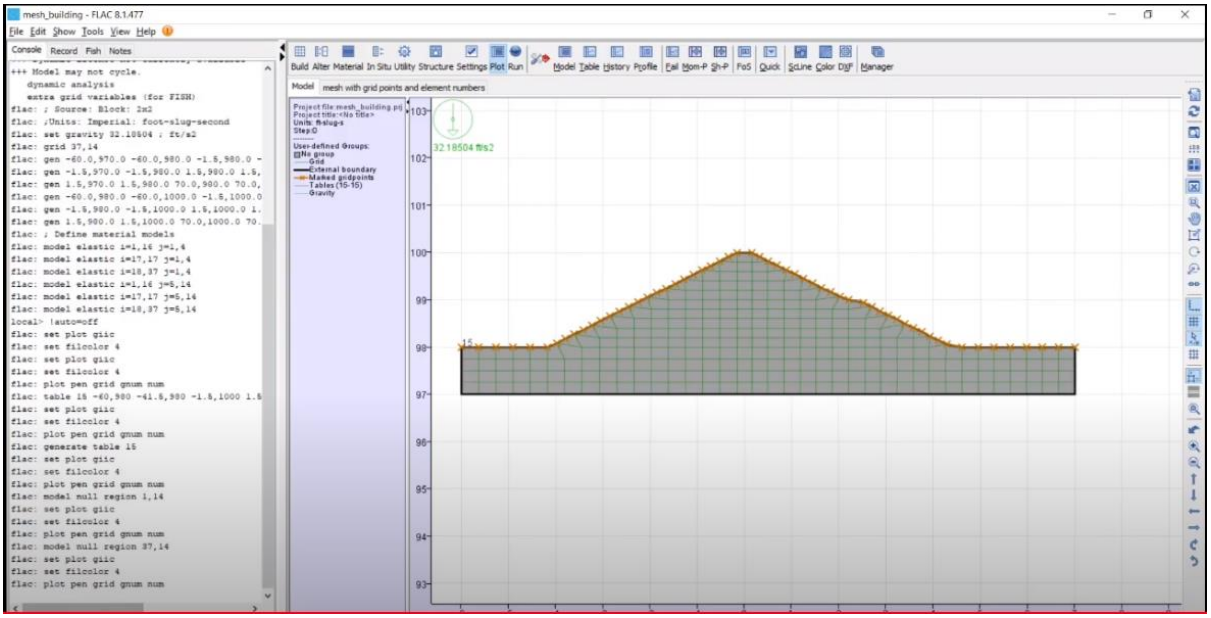


flac: model null region 1,14



flac: model null region 37, 14

Refresh




```
1   flac: config gwflow ats dynamic extra 95
2    Special FLAC configuration:
3      groundwater flow
4      ats on
5   +++ Dynamic license not currently available
6   +++ Model may not cycle.
7      dynamic analysis
8      extra grid variables (for FISH)
9   flac: ;Units: SI: meter-kilogram-second
10  flac: set gravity 9.81 ; m/s2
11  flac: grid 37,14
12  flac: gen -60.0,970.0 -60.0,980.0 -1.5,980.0 -1.5,970.0 i=1,17 j=1,5
13  flac: gen -1.5,970.0 -1.5,980.0 1.5,980.0 1.5,970.0 i=17,18 j=1,5
14  flac: gen 1.5,970.0 1.5,980.0 70.0,980.0 70.0,970.0 i=18,38 j=1,5
15  flac: gen -60.0,980.0 -60.0,1000.0 -1.5,1000.0 -1.5,980.0 i=1,17 j=5,15
16  flac: gen -1.5,980.0 -1.5,1000.0 1.5,1000.0 1.5,980.0 i=17,18 j=5,15
17  flac: gen 1.5,980.0 1.5,1000.0 70.0,1000.0 70.0,980.0 i=18,38 j=5,15
18  flac: ; Define material models
19  flac: model elastic i=1,16 j=1,4
20  flac: model elastic i=17,17 j=1,4
21  flac: model elastic i=18,37 j=1,4
22  flac: model elastic i=1,16 j=5,14
23  flac: model elastic i=17,17 j=5,14
24  flac: model elastic i=18,37 j=5,14
25  local> !auto=off
26  flac: set plot giic
27  flac: set filcolor 4
28  flac: set plot giic
29  flac: set filcolor 4
30  flac: plot pen grid gnum num
31  flac: table 15 -60,980 -41.5,980 -1.5,1000 21.5,990 24,990 44,980 70,980
32  flac: generate table 15
33  flac: model null region 1,14
34  flac: model null region 37, 14
35
```

new

flac: config gwflow ats dynamic extra 95

Special FLAC configuration:

groundwater flow

ats on

+++ Dynamic license not currently available

+++ Model may not cycle.

dynamic analysis

extra grid variables (for FISH)

flac: ;Units: SI: meter-kilogram-second

flac: set gravity 9.81 ; m/s2

flac: grid 37,14

flac: gen -60.0,970.0 -60.0,980.0 -1.5,980.0 -1.5,970.0 i=1,17 j=1,5

flac: gen -1.5,970.0 -1.5,980.0 1.5,980.0 1.5,970.0 i=17,18 j=1,5

flac: gen 1.5,970.0 1.5,980.0 70.0,980.0 70.0,970.0 i=18,38 j=1,5

flac: gen -60.0,980.0 -60.0,1000.0 -1.5,1000.0 -1.5,980.0 i=1,17 j=5,15

flac: gen -1.5,980.0 -1.5,1000.0 1.5,1000.0 1.5,980.0 i=17,18 j=5,15

flac: gen 1.5,980.0 1.5,1000.0 70.0,1000.0 70.0,980.0 i=18,38 j=5,15

flac: ; Define material models

flac: model elastic i=1,16 j=1,4

flac: model elastic i=17,17 j=1,4

flac: model elastic i=18,37 j=1,4

flac: model elastic i=1,16 j=5,14

flac: model elastic i=17,17 j=5,14

flac: model elastic i=18,37 j=5,14

local> !auto=off

flac: set plot giic

flac: set filcolor 4

flac: set plot giic

flac: set filcolor 4

flac: plot pen grid gnum num

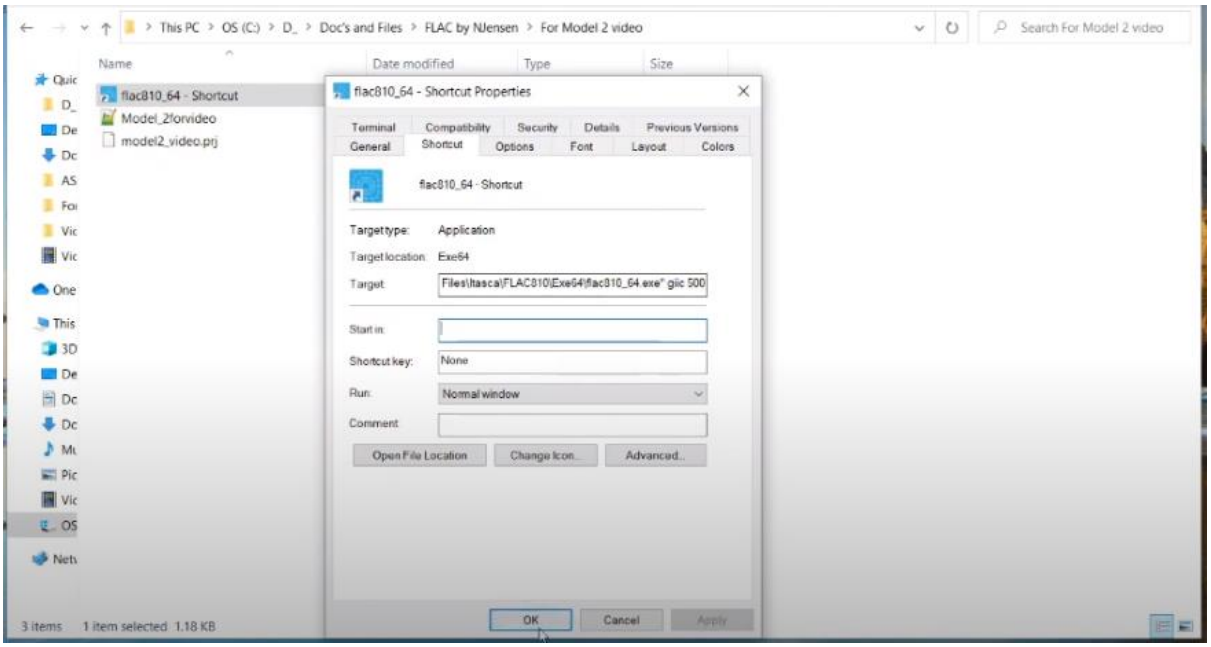
flac: table 15 -60,980 -41.5,980 -1.5,1000 21.5,990 24,990 44,980 70,980

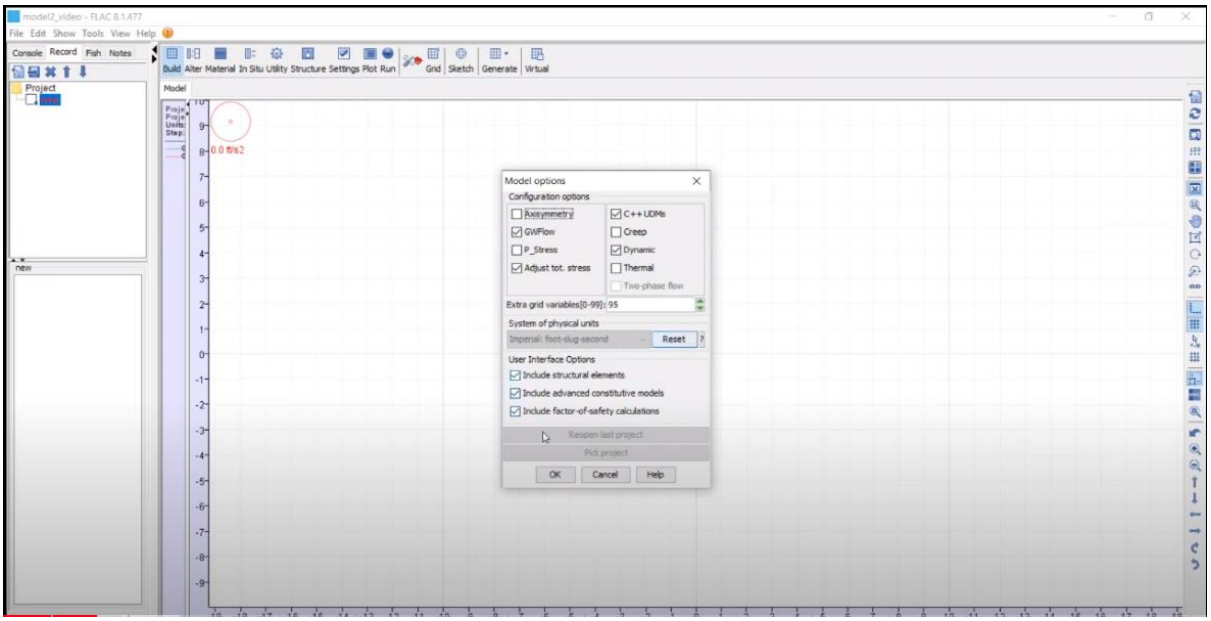
flac: generate table 15

flac: model null region 1,14

flac: model null region 37, 14

Part 2






```
;++++ Configurations and initial sets: ++++

new
config dyn gw ex 95 ats      ;Not all extra variables have to be used
set grav=32.18504            ;Gravity in Imperial units
set flow= off dyn= off echo= on
set small            ;small strain used for now
water bulk=0         ;water bulk is set to 0 for now, drained when Kw=
water density=1.9379

;-----------------------------------------------------------------------
;Step 2: Mesh and Geometry
;-----------------------------------------------------------------------
```

new

config gwflow ats dynamic extra 95

;Units: SI: meter-kilogram-second

set gravity 9.81 ; m/s2

set flow= off dyn= off echo= on

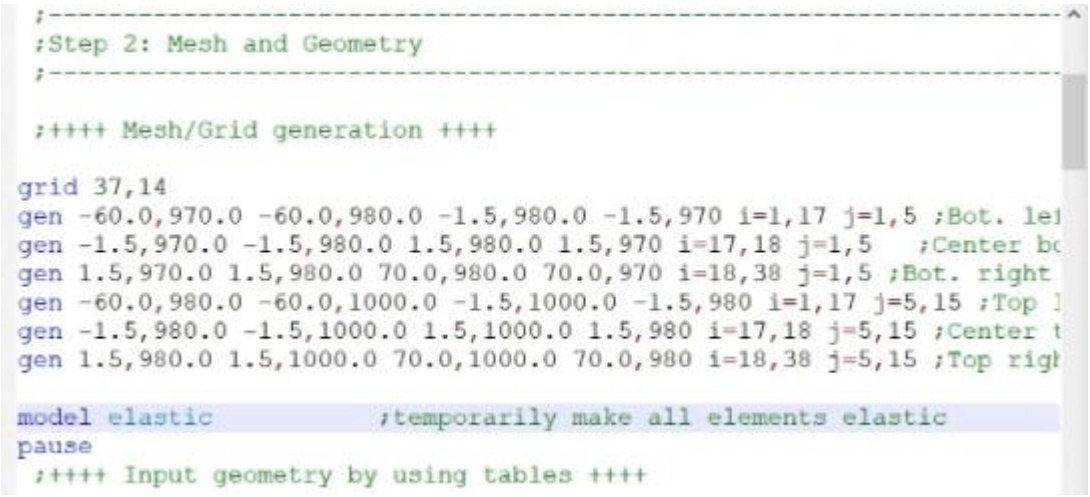
set small

water bulk=0

;water density=1.9379 ->>> SI units

water density=1000

pause



grid 37,14

gen -60.0,970.0 -60.0,980.0 -1.5,980.0 -1.5,970.0 i=1,17 j=1,5

gen -1.5,970.0 -1.5,980.0 1.5,980.0 1.5,970.0 i=17,18 j=1,5

gen 1.5,970.0 1.5,980.0 70.0,980.0 70.0,970.0 i=18,38 j=1,5

gen -60.0,980.0 -60.0,1000.0 -1.5,1000.0 -1.5,980.0 i=1,17 j=5,15

gen -1.5,980.0 -1.5,1000.0 1.5,1000.0 1.5,980.0 i=17,18 j=5,15

gen 1.5,980.0 1.5,1000.0 70.0,1000.0 70.0,980.0 i=18,38 j=5,15

; Define material models

model elastic

pause

```
;pause
;++++ Input geometry by using tables ++++

table 1 delete                          ;'u/s shell'
table 1 -41.5,980 -1.5,1000 -8,980 -41.5,980

table 2 delete                          ;'d/s shell'
table 2 1.5,1000 21.5,990 24,990 44,980 8,980 1.5,1000

table 3 delete                          ;'Core'
table 3 -1.5,1000 1.5,1000 8,980 1.5,975 -1.5,975 -8,980 -1.5,1000

table 4 delete                          ;'u/s foundation'
table 4 -60,975 -60,980 -8,980 -1.5,975 -60,975

table 5 delete                          ;'d/s foundation'
table 5 1.5,975 8,980 70,980 70,975 1.5,975

table 6 delete                          ;'Bedrock'
table 6 -60,970 -60,975 70,975 70,970 -60,970
pause
```

table 1 delete ;'u/s shell’

table 1 -41.5,980 -1.5,1000 -8,980 -41.5,980

table 2 delete ;d/s shell’

table 2 1.5,1000 21.5,990 24,990 44,980 8,980 1.5,1000

table 3 delete ;'Core'

table 3 -1.5,1000 1.5,1000 8,980 1.5,975 -1.5,975 -8,980 -1.5,1000

table 4 delete ;'u/s foundation’

table 4 -60,975 -60,980 -8,980 -1.5,975 -60,975

table 5 delete ;'d/s fundation'

table 5 1.5,975 8,980 70,980 70,975 1.5,975

table 6 delete ;‘Bedrock'

table 6 -60,970 -60,975 70,975 70,970 -60,970

pause

flac: Call filename.txt

Plot -> Model

flac: continue

RMB ---> show Table

Refresh

```
pause
 ;++++ null out table above ground surface to make geometry ++++

table 141 delete                        ;Table for ground surface
table 141 -60,980 -41.5,980 -1.5,1000 1.5,1000 21.5,990 24,990 44,980 70,980

gen table 141             ;generate ground surface
mod null reg 1,14         ;null out zones above the ground surface on the u/s sid
mod null reg 37,14        ;null out zones above the ground surface on the d/s sid
pause
 ;+++ Make d/s bench look better, not necessary for performance +++
ini x 24.0 y 990 i 25 j 10 ;Moves i,j gridpt 25,10 to x,y coord of 24,990
ini x 21.5 y 990 i 24 j 10 ;Moves i,j gridpt 24,10 to x,y coord of 21.5,990
pause
 ;-------------------------------------------------------------------------;
 ;Step 3: Input initial properties                                         ;
 ;-------------------------------------------------------------------------;
```

;++++ null out table above ground surface to make geometry

table 141 delete ;Table for ground surface

table 141 -60,980 -41.5,980 -1.5,1000 1.5,1000 21.5,990 24,990 44,980 70,980

gen table 141 ;gen ground surface

mod null reg 1,14 ;null out zones an the u/s side

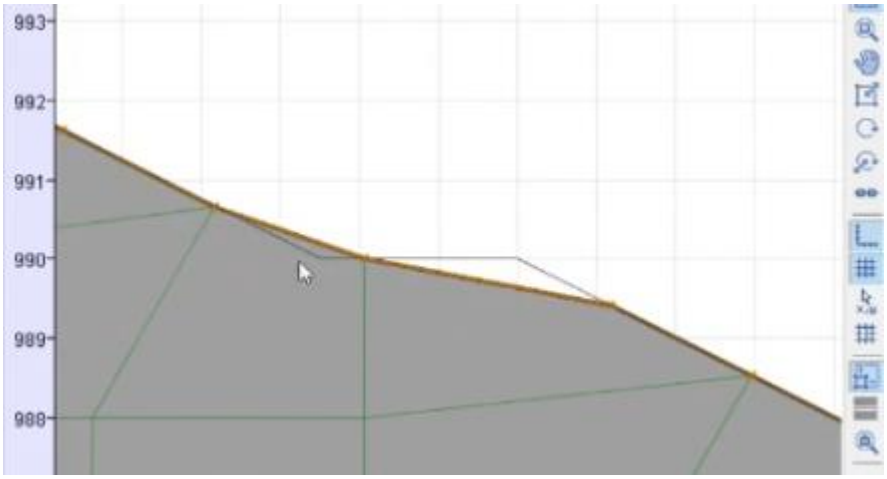
mod null reg 37,14 ;null out zones above d/s side

;++++ Make d/s bench look better

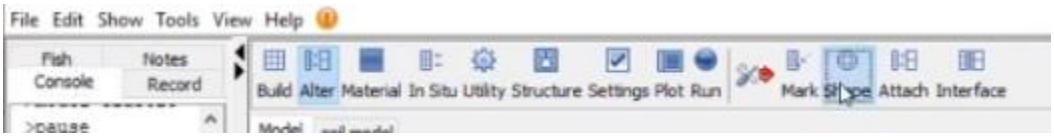
ini x 24.0 y 990 i 25 j 10 ;Moves i,j grd ...

ini x 21.5 y 990 i 24 j 10 ;Moves i,j grd ...

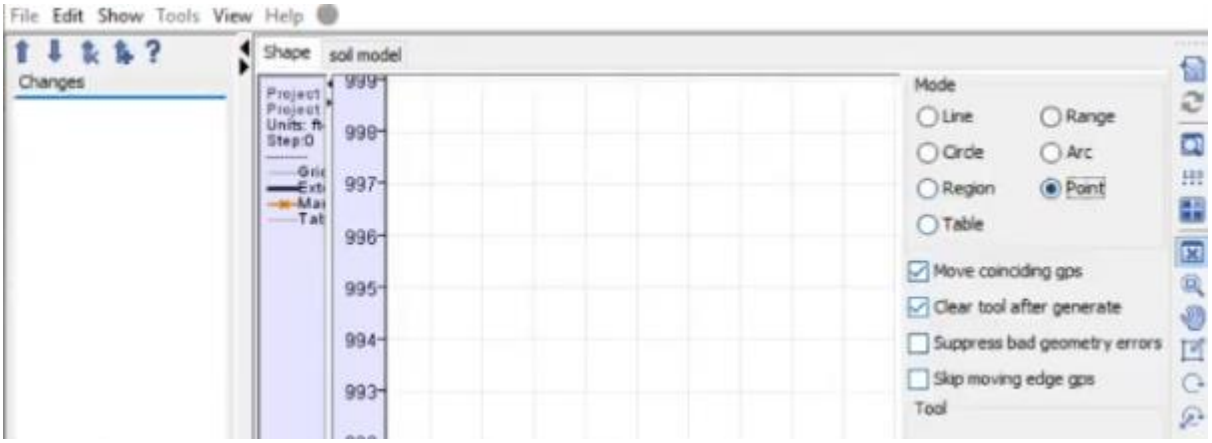
pause

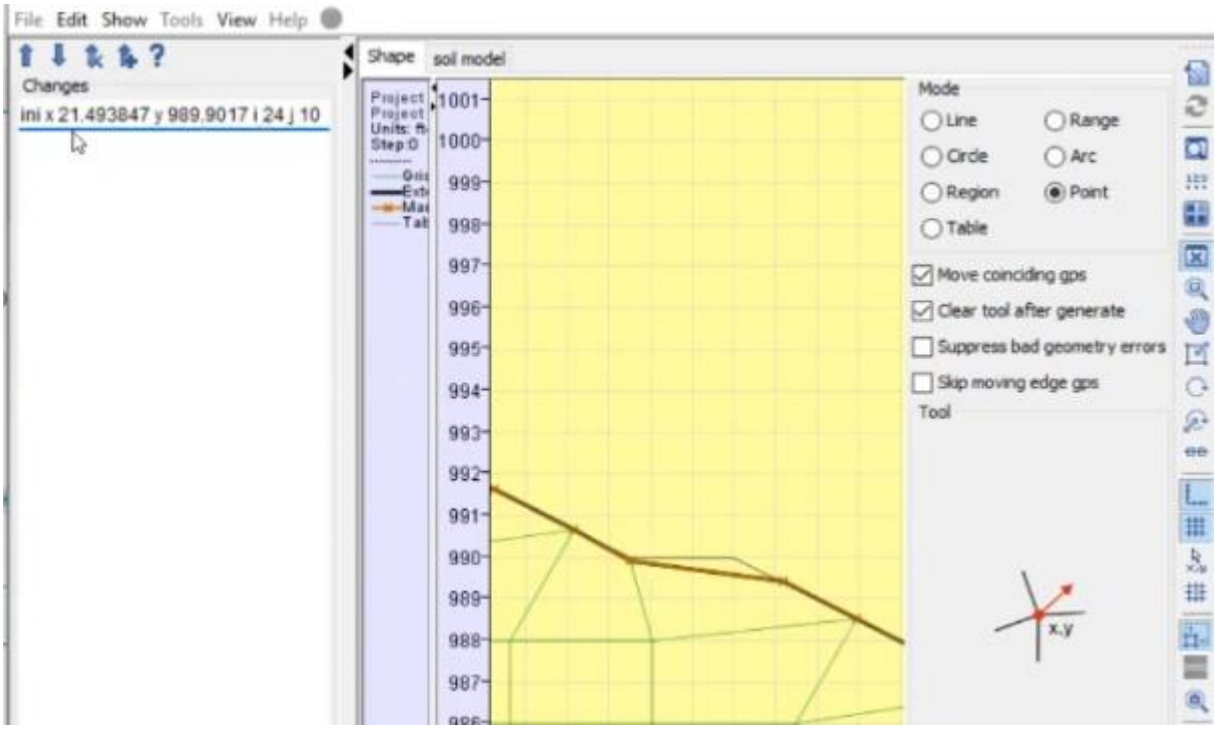


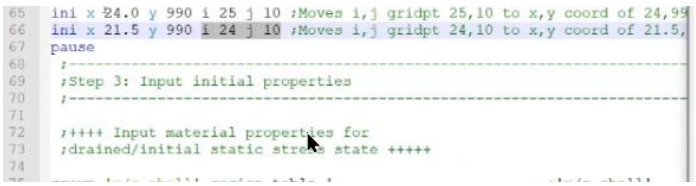
Alter -> Shape

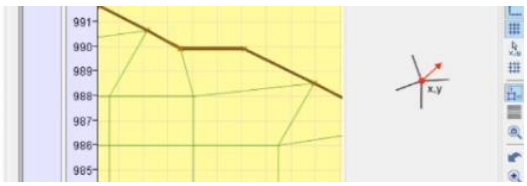


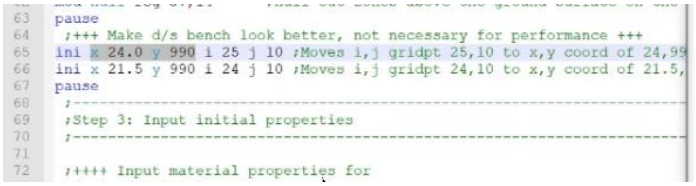
Mode -> Point

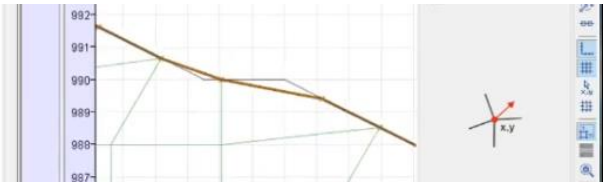

File Edit Show Tools View Help
Changes
Shape soil model
Mode
Line
Range
Circle
Arc
Region
Point
Table
Move coinciding gps
Clear tool after generate
Suppress bad geometry errors
Skip moving edge gps
Tool


File Edit Show Tools View Help
Changes
ini x 21.493847 y 989.9017 i 24 j 10
Shape soil model
Mode
Line
Range
Circle
Arc
Region
Point
Table
Move coinciding gps
Clear tool after generate
Suppress bad geometry errors
Skip moving edge gps
Tool
x,y


ini x 24.0 y 990 i 25 j 10 ;Moves i,j gridpt 25,10 to x,y coord of 24,99
ini x 21.5 y 990 i 24 j 10 ;Moves i,j gridpt 24,10 to x,y coord of 21.5,
pause
;Step 3: Input initial properties
;++++ Input material properties for
;drained/initial static


x,y


pause
;+++ Make d/s bench look better, not necessary for performance +++
ini x 24.0 y 990 i 25 j 10 ;Moves i,j gridpt 25,10 to x,y coord of 24,99
ini x 21.5 y 990 i 24 j 10 ;Moves i,j gridpt 24,10 to x,y coord of 21.5,
pause
;Step 3: Input initial properties
;++++ Input material properties for

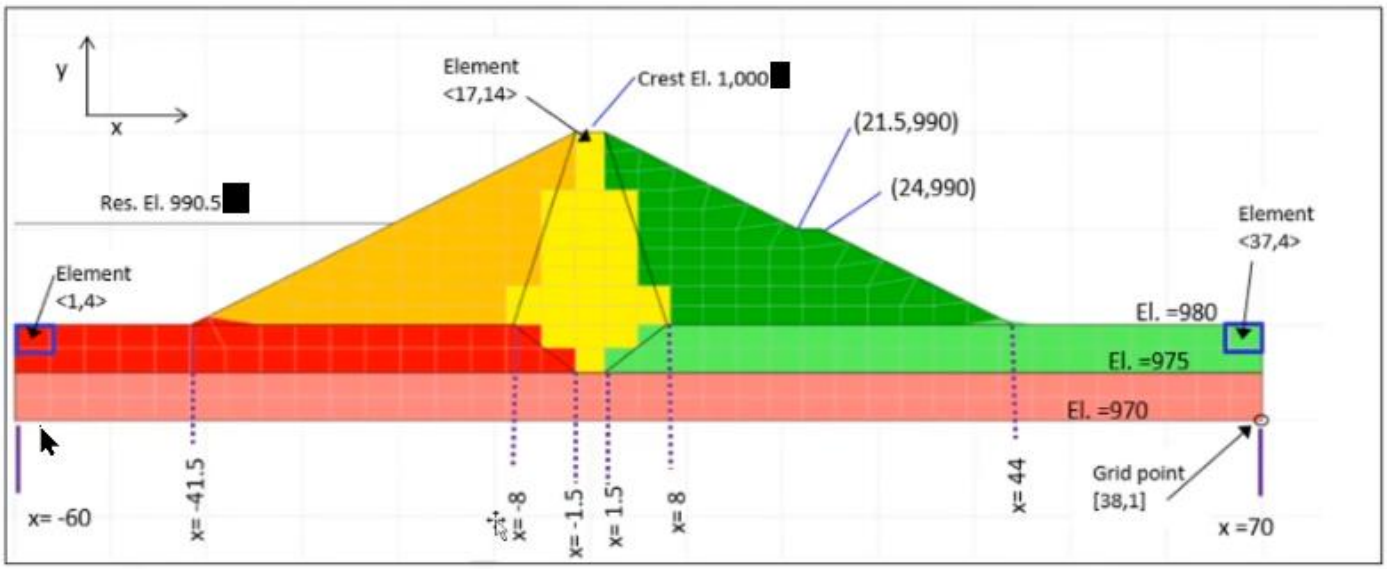

x,y

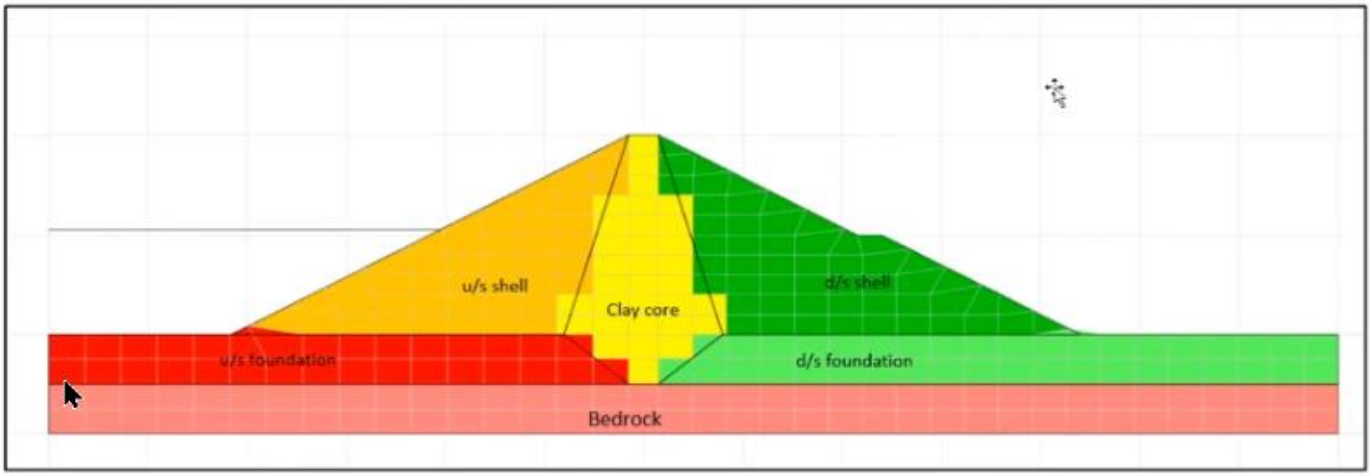
Flac: cont

Part 3 (4-8.12.2023)

```
;-------------------------------------------------------------------------;
;Step 3: Input initial properties                                         ;
;-------------------------------------------------------------------------;

;++++ Input material properties for
;drained/initial static stress state +++++

group 'u/s shell' region table 1                        ;'u/s shell'
model mohr group 'u/s shell'                            ;model mohr
prop d=3.42 s=2.47e6 b=6.43e6 c=100 f=32 ten=160 &      ;prop's for the group
poros=.25 perm=5.26e-9 group 'u/s shell'

group 'd/s shell' region table 2                        ;'d/s shell'
model mohr group 'd/s shell'                            ;model mohr
prop d=3.42 s=2.47e6 b=6.43e6 c=100 f=32 ten=160 &      ;prop's for the group
poros=.25 perm=5.26e-9 group 'd/s shell'

group 'Core (sandy clay)' region table 3                ;'Core (sandy clay)'
model mohr group 'Core (sandy clay)'                    ;model mohr
prop d=3.42 s=3.85e6 b=1.01e7 c=300 f=28 ten=564 &      ;prop's for the group
poros=.25 perm=5.26e-9 group 'Core (sandy clay)'

group 'u/s foundation' region table 4                   ;'u/s foundation'
model mohr group 'u/s foundation'                       ;model mohr
prop d=3.15  s=1.41e6 b=3.67e6 c=100 f=28 ten=188 &     ;prop's for the group
poros=.39 perm=5.26e-9 group 'u/s foundation'

group 'd/s foundation' region table 5                   ;'d/s foundation'
model mohr group 'd/s foundation'                       ;model mohr
prop d=3.15 s=1.41e6 b=3.67e6 c=100 f=28 ten=188 &      ;prop's for the group
poros=.39 perm=5.26e-8 group 'd/s foundation'
```

```
group 'Bedrock' region table 6                          ;'Bedrock'
model mohr group 'Bedrock'                              ;model mohr
prop d=4.19 s=1.69e7 b=4.40e7 c=2000 f=36 ten=2753 &    ;prop's for the
poros=.01 perm=5.26e-12 group 'Bedrock'
 ;pause
pause
```





Material	γ (dry) pcf	Saturation for unsat state	porosity (n)	γ (unsat) pcf	γ (sat) pcf
u/s shell	110.0	0.90	0.25	124.0	125.6
d/s shell	110.0	0.90	0.25	124.0	125.6
Core	110.0	0.90	0.25	124.0	125.6
u/s foundation	101.5	1.00	0.39	125.8	125.8
d/s foundation	101.5	1.00	0.39	125.8	125.8
Bedrock	135.0	1.00	0.01	135.6	135.6

Material	Vs (ft/sec)	Vp (ft/sec)	G, unsat shear modulus (psf)	G, sat shear modulus (psf)	Poisson's ratio (ν)		K, Drained & unsat (psf)	K, Drained saturated (psf)	K, dynamic bulk modulus (psf)
					ν (Static)	ν (Dyn)			
u/s shell	800	2280	2.47E+06	2.50E+06	0.330	0.430	6.43E+06	6.51E+06	1.70E+07
d/s shell	800	2280	2.47E+06	2.50E+06	0.330	0.430	6.43E+06	6.51E+06	1.70E+07
Core	1000	3050	3.85E+06	3.90E+06	0.330	0.440	1.01E+07	1.02E+07	3.11E+07
u/s foundation	600	2600	1.41E+06	1.41E+06	0.330	0.472	3.67E+06	3.67E+06	2.46E+07
d/s foundation	600	2600	1.41E+06	1.41E+06	0.330	0.472	3.67E+06	3.67E+06	2.46E+07
Bedrock	2000	3970	1.69E+07	1.69E+07	0.330	0.330	4.40E+07	4.40E+07	4.39E+07

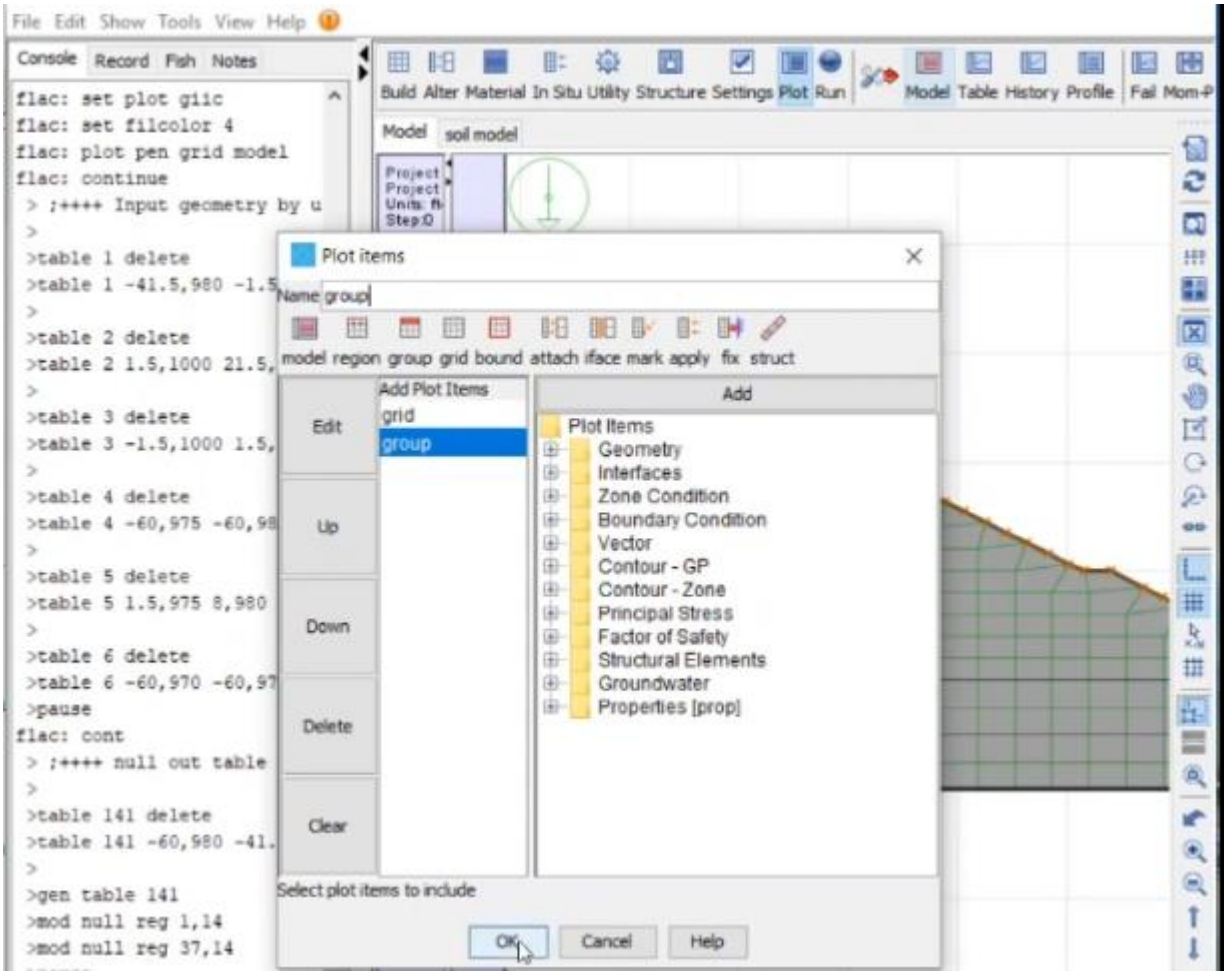
Material	Drained Strengths		Tensile strength (psf)	k (hydr. Cond.) (ft/sec)
	cohesion (psf)	friction (deg)		
u/s shell	100	32	160	3.28E-08
d/s shell	100	32	160	3.28E-08
Core	300	28	564	3.28E-10
u/s foundation	100	28	188	3.28E-08
d/s foundation	100	28	188	3.28E-08
Bedrock	2000	36	2,753	3.28E-11

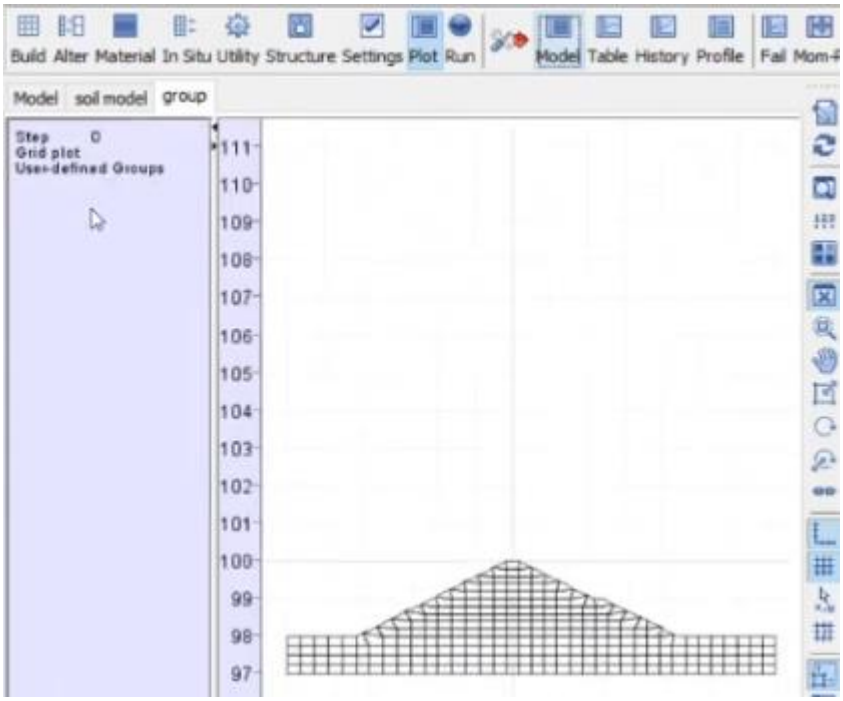
Plot -> Model

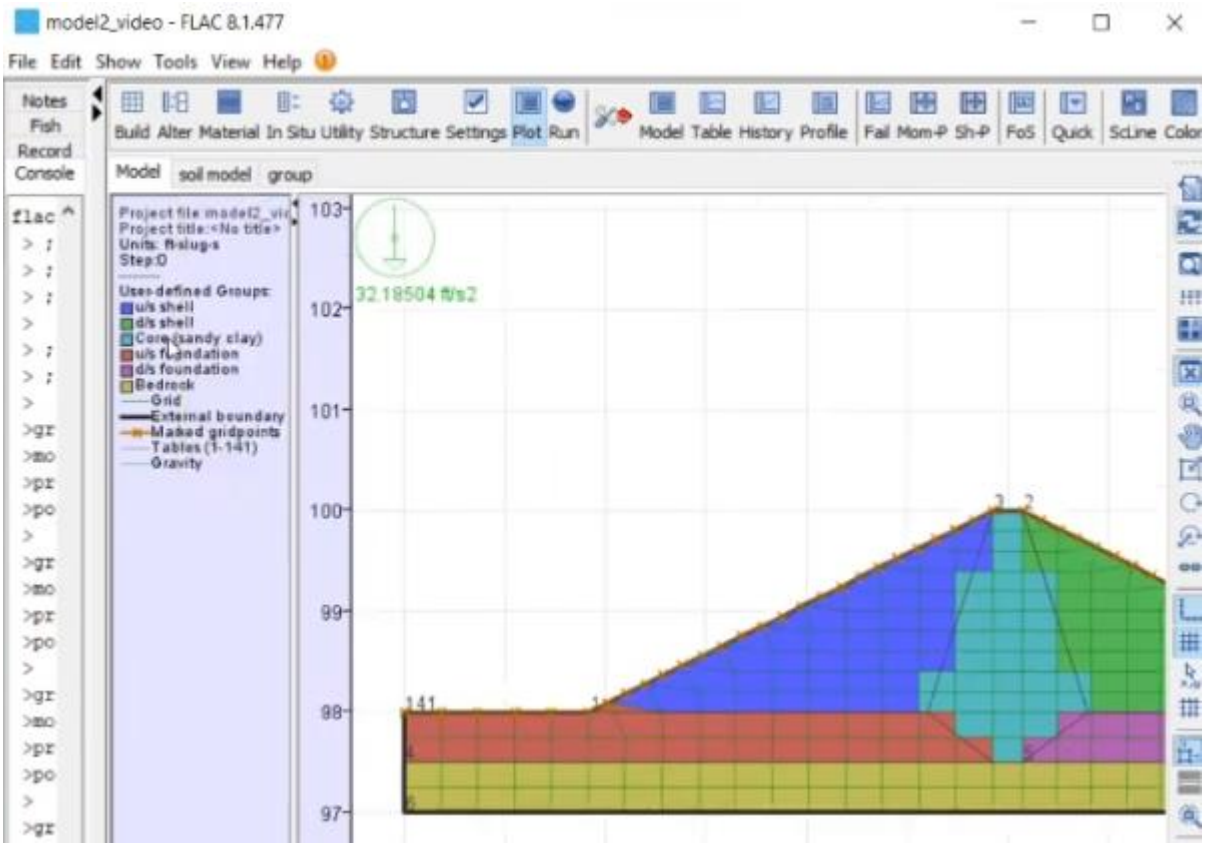
Add -> grid

Add -> group

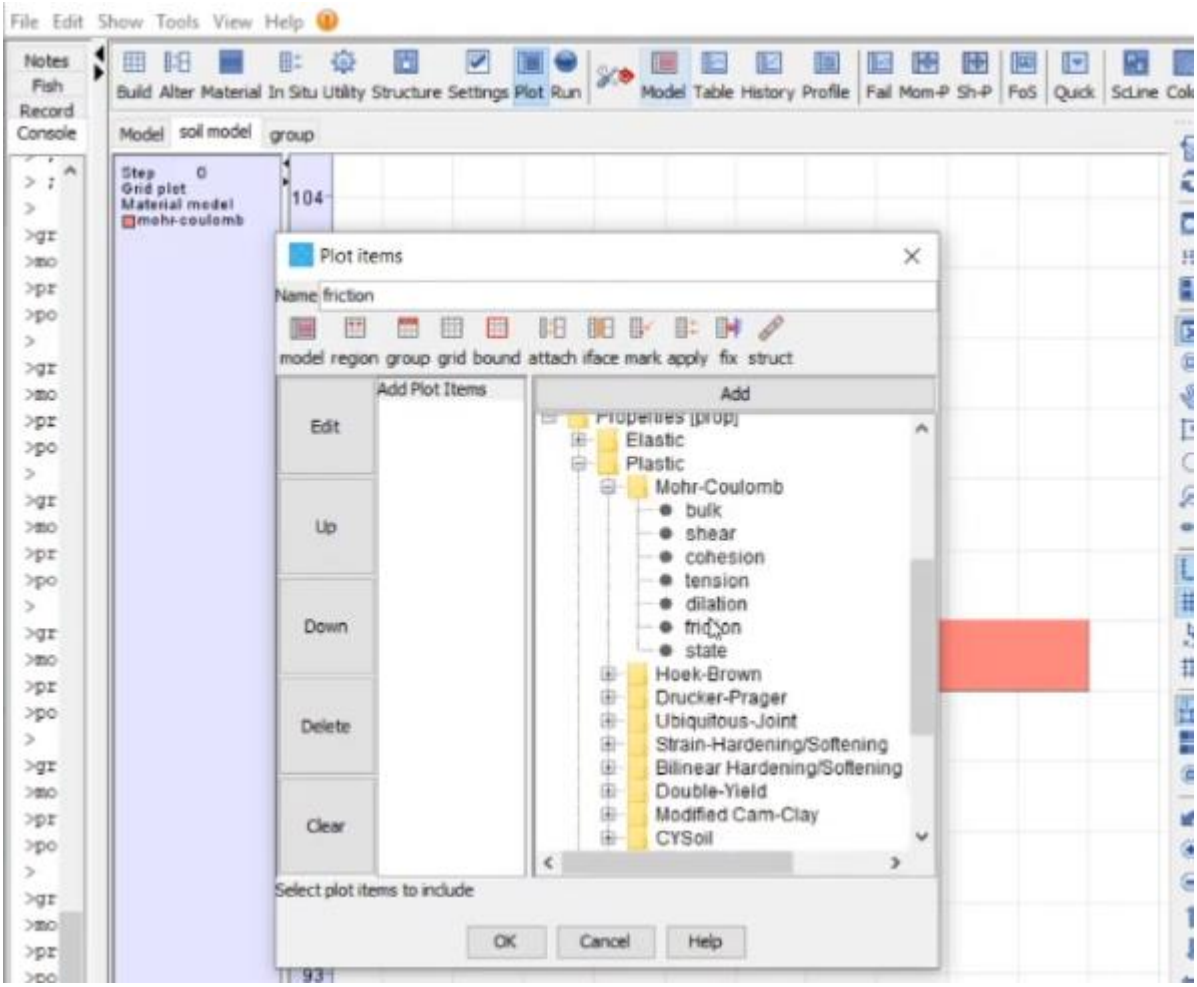
OK


File Edit Show Tools View Help
Console Record Fish Notes
flac: set plot giic
flac: set filcolor 4
flac: plot pen grid model
flac: continue
> ;++++ Input geometry by u
>table 1 delete
>table 1 -41.5,980 -1.5
>table 2 delete
>table 2 1.5,1000 21.5,
>table 3 delete
>table 3 -1.5,1000 1.5,
>table 4 delete
>table 4 -60,975 -60,98
>table 5 delete
>table 5 1.5,975 8,980
>table 6 delete
>table 6 -60,970 -60,97
>pause
flac: cont
> ;++++ null out table
>table 141 delete
>table 141 -60,980 -41.
>gen table 141
>mod null reg 1,14
>mod null reg 37,14
Build Alter Material In Situ Utility Structure Settings Plot Run
Model Table History Profile Fail
Model soil model
Plot items
Name group
model region group grid bound attach iface mark apply fix struct
Edit
Up
Down
Delete
Clear
Add Plot Items
grid
group
Add
Plot Items
Geometry
Interfaces
Zone Condition
Boundary Condition
Vector
Contour - GP
Contour - Zone
Principal Stress
Factor of Safety
Structural Elements
Groundwater
Properties [prop]
Select plot items to include
OK
Cancel
Help


Build Alter Material In Situ Utility Structure Settings Plot Run
Model Table History Profile Fail
Model soil model group
Step 0
Grid plot
User-defined Groups
111
110
109
108
107
106
105
104
103
102
101
100
99
98
97



Plot -> Model -> Properties -> Plastic -> Mohr-Coulomb -> friction



```
;-------------------------------------------------------------------------;
;Step 4: Set up for initial static-solve                                  ;
;-------------------------------------------------------------------------;
;++++ set initial saturation->sat. levels w/ no phreatic ++++

initial saturation 0.90              ;Makes all gridpoints have sat = 0.90, then
initial saturation 1.0 i 1 38 j 1 5 ;Bedrock and foundation grid points, sat=1.
pause
;Initial GWT at ground surface elevation of 980ft:
table 39 -60,980 70,980
water table 39
pause
;+++ Fixed BCs for static solve, will change for dyn. solve ++++

fix  x y i 1 38 j 1      ;bottom
fix  x i 1 j 2 5         ;u/s end
fix  x i 38 j 2 5        ;d/s end
pause

;++++ First solve, solve elastic, no reservoir or phreatic yet ++++

solve elastic
pause
;-------------------------------------------------------------------------;
```