Pipe Stress Analyis Guide Report

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1. Information Needed for Pipe Stress-Analysis

See example Iso.

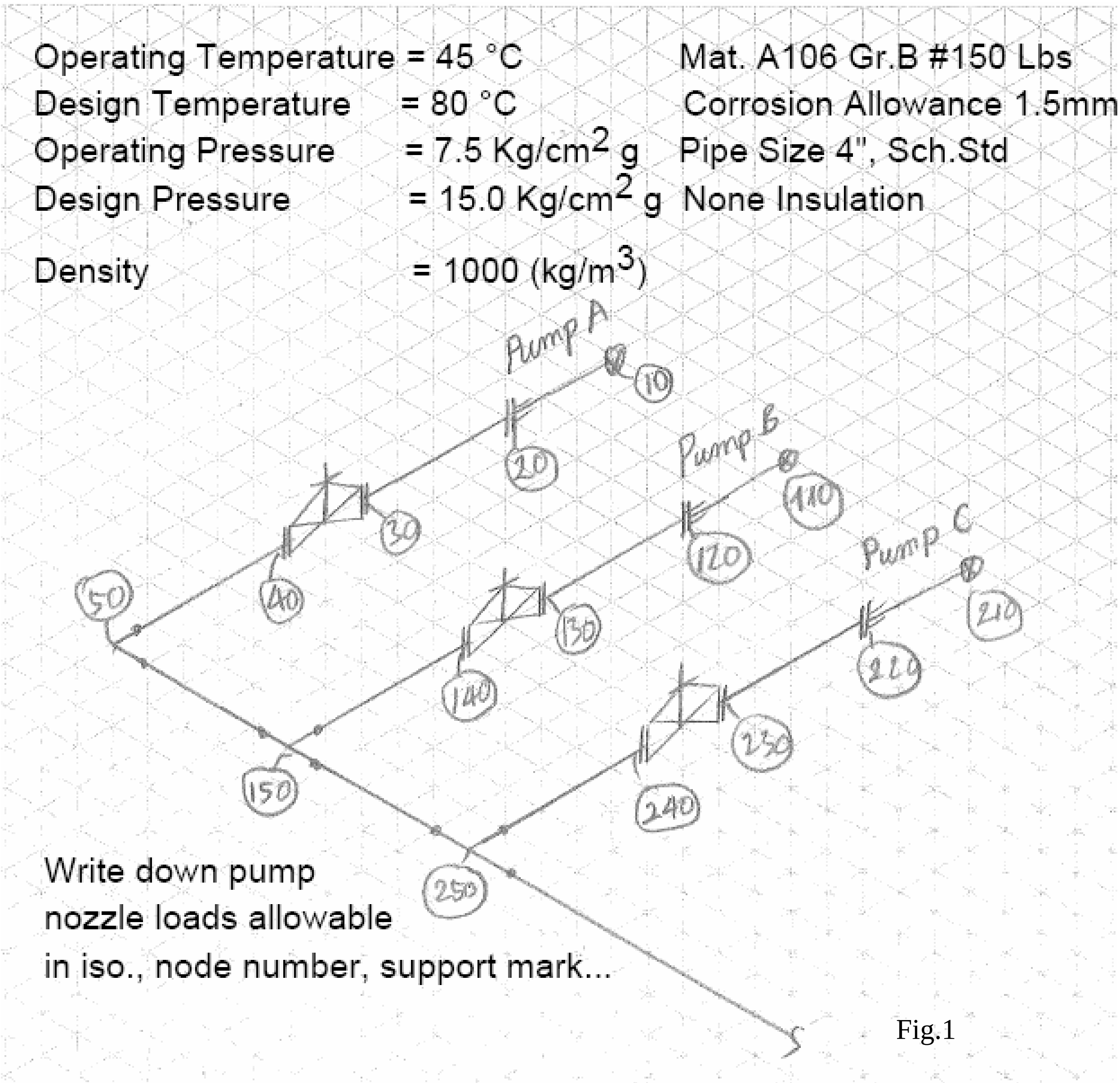


Fig.1

Here are needed information.

1. Outside diameter of piping, wall thickness (or nominal diameter, schedule number)
2. Temperature, internal pressure
3. Material of piping. (Expansion coeffcient, Young's modulus, and material density will be selected for this material.)
4. Insulation thickness and insulation material. (If not given, standard thickness for calcium silicate will be selected.)
5. Specifc gravity of contents
6. Any wind load to be considered? If yes, the direction of application is important.
7. Any anchor initial translation. (For towers, exchangers, and so on, nozzle initial ranslation is important.)
8. Corrosion allowance for piping
9. Flange rating, (ANSI B16.5)
10. Standard valve weight and fange weight will be used. (For special valves mark the weight on pipe stress isometric.)
11. Long radius elbows will be used. (If short radius or any other bend radius, mark on the isometric.) For short-radius elbow, radius= diameter

12. Any allowable loading from manufacturers on pumps, turbines, compressors? (From the vendor drawing for equipment.)
13. Any preference to use expansion loops, expansion joints, and so on, if needed?
14. Mark type of intersection (reinforced fabricated tee, etc.)
15. Mark support locations (available steel crossing, and so on) on the isometric
16. Is hydraulic testing load condition to be considered to get structural support loads?
17. Pipe stress isometrics (x-, y-, z-axis) piping plans, and sections are necessary.

Reference

-Experienced in piping stress analysis using Caesar II

-Introduction to pipe stress analysis book, by Sam Kannappan, P.E. Engineer

2.Temperature Conditions for Piping Stress Analysis Consideration

Before you start piping stress calculation, you have to refer to line index (or called the line classification lists or process line lists) to check design temperature and an operating temperature for line to be checked.Stress analysis shall be carried out on the basis of the design temperature.
Secondly, you have to know requirements base on your project specification such as
Minimum Ambient Temperature. (T_{AMIN})
Maximum Ambient Temperature. (T_{AMAX})
Maximum Solar Radiation Temperature. (T_S)
Site Installation Temperature. (T_{As})

We will use value below in our piping stress analysis tutorials:

T_{AMIN} = 16°C (For Stress Range Purpose, in case hot lines)
T_{AMAX} = 36°C (For Stress Range Purpose , incase cold lines)
T_S = 70°C
T_{As} = 21°C
Line design temperature shall be taken from process line lists (or line index).

In case plus design temperatures <70°C , 70°C will be taken as design temperature

Example 1:

Line design temperature as per line index is 65°C so we will take 70°C as design temperature for stress calculation
T_{AMIN} = 16°C (For Stress Range Purpose)
T_{As} = 21°C

Example 2:
Line design temperature as per line index is -250°C so we will take -250°C as design temperature for stress calculation
T_{AMAX} = 36°C (For Stress Range Purpose with)
T_{As} = 21°C

Noted:
T_{AMIN}= 16°C in example 1 (for hot line) and T_{AMAX} = 36°C in example 2 (for cold line)
You have to find Minimum Ambient Temperature, Maximum Ambient Temperature, Maximum Solar Radiation Temperature, Site Installation Temperature in your project specifications

3. How to setup load cases

a. LOAD CASE DEFINITION KEY (3 PUMPS)

Reference to Iso. In Fig.1

```
CASE 1 (HYD) WW+HP         (without friction, or called none-friction)
CASE 2 (OPE) W+T1+P1       (with friction)
CASE 3 (OPE) W+T1+P1       (without friction, or called none-friction)
CASE 4 (OPE) W+T2+P1       (with friction)
CASE 5 (OPE) W+T3+P1       (with friction)
CASE 6 (OPE) W+T4+P1       (with friction)
CASE 7 (OPE) W+T5+P1       (without friction, or called none-friction)
CASE 8 (SUS) W+P1          (with friction)
CASE 9 (SUS) W+P1          (without friction, or called none-friction)
CASE 10 (OCC) U1           (without friction, or called none-friction)
CASE 11 (OCC) U2           (without friction, or called none-friction)
CASE 12 (OCC) L12=L10+L11  (without friction, or called none-friction)
CASE 13 (OCC) L13=L12+L9   (without friction, or called none-friction)
CASE 14 (EXP) L14=L2-L8    (with friction)
CASE 15 (EXP) L15=L3-L9    (without friction, or called none-friction)
CASE 16 (EXP) L16=L7-L9    (without friction, or called none-friction)
CASE 17 (EXP) L17=L15+L16  (without friction, or called none-friction)
```

Explain

Hydro Test Case

Case1: Hydro Test case, *none-friction* with WW=Water Filled Weight, HP=Hydro Pressure

Operation Case

Case2: Operating case with friction at operating temperature (T1=80°C), 3 pumps working
Case3: Operating case *none-friction* at operating temperature (T1=80°C), 3 pumps working
Case4: Operating case with friction, pumpA and pumpB working (T2=80°C), pump C standby (T2=21°C)
Case5: Operating case with friction, pumpA and pumpC working (T3=80°C), pump B standby (T3=21°C)
Case6: Operating case with friction, pumpB and pumpC working (T4=80°C), pump A standby (T4=21°C)
Case7: Operating case *none-friction* at T_{AMIN} = 16°C (For Stress Range Purpose), 3 pumps at T5=16°C

Sustain Case

Case8: Sustain case with friction
Case9: Sustain case none- friction

Occational Case

Case10: Seismic Load (X direction), none- friction
Case11: Seismic Load (Z direction), none- friction
Case12: Seismic Load combined, none- friction
Case13: Sustain Case + Occational due to seismic, none- friction

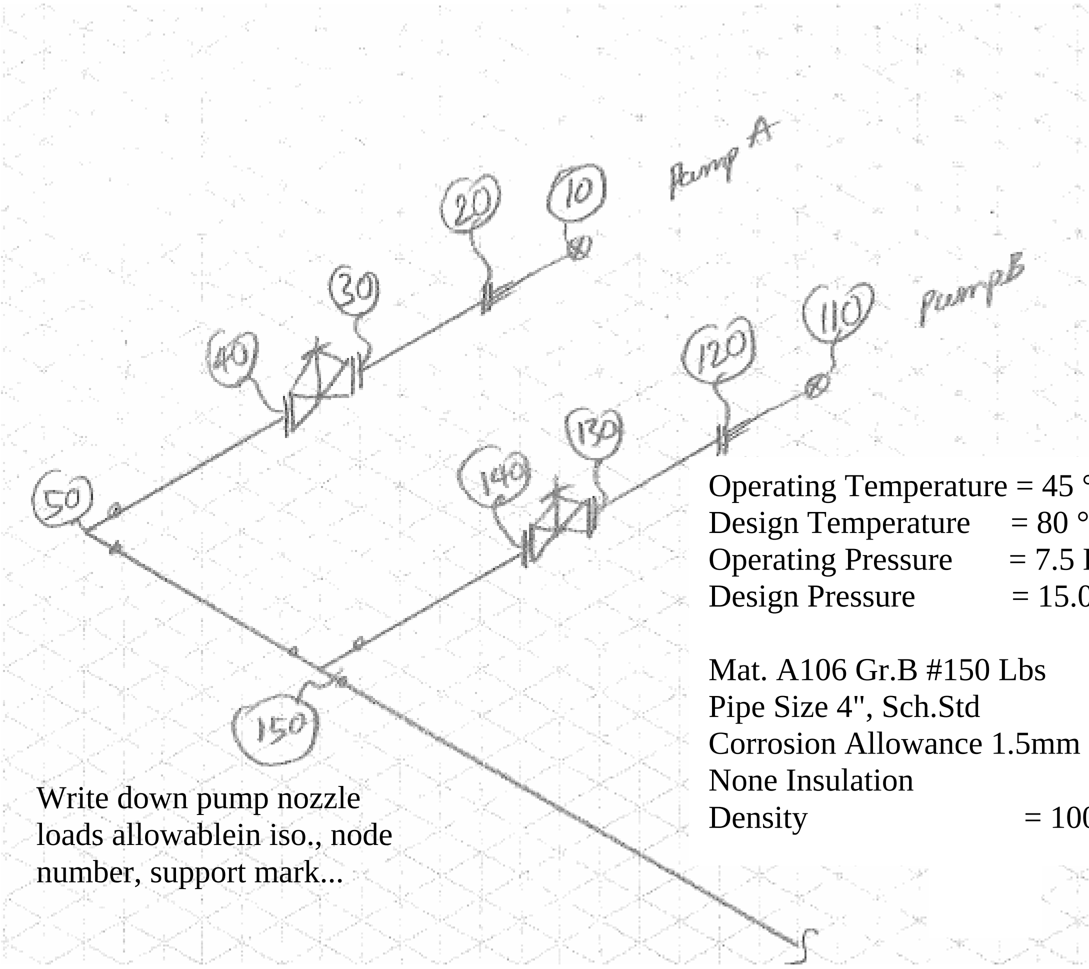
Expansion Case

Case14:Expansion Case check with friction at operating temperature (T1=80°C)
Case15:Expansion Case check none- friction at operating temperature (T1=80°C)
This is stress check at maximum temperature, none- friction
Case16:Expansion Case check none- friction at mininum temperature (T5=16°C)
This is stress check at maximum temperature, none- friction
Case17:This case for stress range purpose, none- friction
[minimum stress check(case16)+maximum stress check(case15)]

Please click link below to see videos about above tutorials
http://www.azpiping.com/tutorials/temperature-3pumps.htm
http://www.azpiping.com/tutorials/loads-3pumps.htm

b LOAD CASE DEFINITION KEY (2 PUMPS)

Reference to Iso. In Fig.2



Operating Temperature = 45 °C
Design Temperature = 80 °C
Operating Pressure = 7.5 Kg/cm^2 g
Design Pressure = 15.0 Kg/cm^2 g

Mat. A106 Gr.B #150 Lbs
Pipe Size 4", Sch.Std
Corrosion Allowance 1.5mm
None Insulation
Density = 1000 (kg/m^3)

Write down pump nozzle loads allowablein iso., node number, support mark...

CASE 1 (HYD) WW+HP	*(without friction, or called none-friction)*
CASE 2 (OPE) W+T1+P1	(with friction)
CASE 3 (OPE) W+T1+P1	*(without friction, or called none-friction)*
CASE 4 (OPE) W+T2+P1	(with friction)
CASE 5 (OPE) W+T3+P1	(with friction)
CASE 6 (OPE) W+T4+P1	*(without friction, or called none-friction)*
CASE 7 (SUS) W+P1	(with friction)
CASE 8 (SUS) W+P1	*(without friction, or called none-friction)*
CASE 9 (OCC) U1	*(without friction, or called none-friction)*
CASE 10 (OCC) U2	*(without friction, or called none-friction)*
CASE 11 (OCC) L11=L9+L10	*(without friction, or called none-friction)*
CASE 12 (OCC) L12=L11+L8	*(without friction, or called none-friction)*
CASE 13 (EXP) L13=L2-L7	(with friction)
CASE 14 (EXP) L14=L3-L8	*(without friction, or called none-friction)*
CASE 15 (EXP) L15=L6-L8	*(without friction, or called none-friction)*
CASE 16 (EXP) L16=L14+L15	*(without friction, or called none-friction)*

Explain

Hydro Test Case

Case1: Hydro Test case, *none-friction* with WW=Water Filled Weight, HP=Hydro Pressure

Operation Case

Case2: Operating case with friction at operating temperature (T1=80°C), 2 pumps working
Case3: Operating case *none-friction* at operating temperature (T1=80°C), 2 pumps working
Case4: Operating case with friction, pumpA and (T2=80°C), pump B standby (T2=21°C)
Case5: Operating case with friction, pumpB working (T3=80°C), pump A standby (T3=21°C)
Case6: Operating case *none-friction* at T_{AMIN} = 16°C (For Stress Range Purpose), 2 pumps at T4=16°C

Sustain Case

Case7: Sustain case with friction
Case8: Sustain case none- friction

Occational Case

Case9: Seismic Load (X direction), none- friction
Case10: Seismic Load (Z direction), none- friction
Case11: Seismic Load combined, none- friction
Case12: Sustain Case + Occational due to seismic, none- friction

Expansion Case

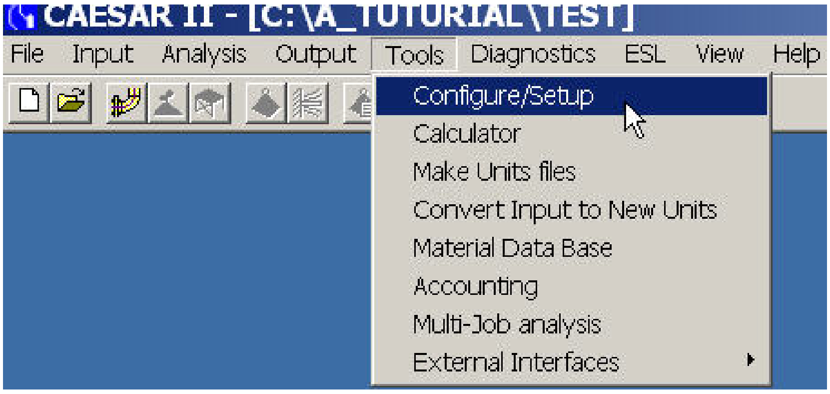
Case13:Expansion Case check with friction at operating temperature (T1=80°C)
Case14:Expansion Case check none- friction at operating temperature (T1=80°C)
This is stress check at maximum temperature, none- friction
Case15:Expansion Case check none- friction at mininum temperature (T4=16°C)
This is stress check at maximum temperature, none- friction
Case16:This case for stress range purpose, none- friction
[minimum stress check(case15)+maximum stress check(case14)]

Please click link below to see videos about above tutorials

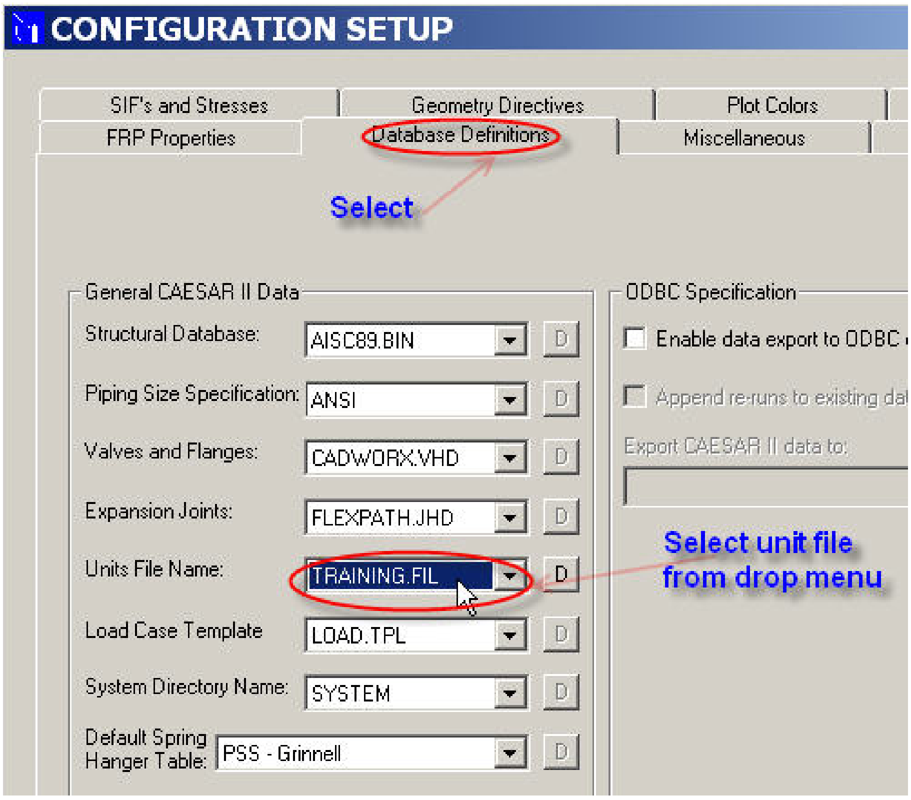
http://www.azpiping.com/tutorials/temperature-2pumps.htm
http://www.azpiping.com/tutorials/loads-2pumps.htm

3. Some notes when making new calculation

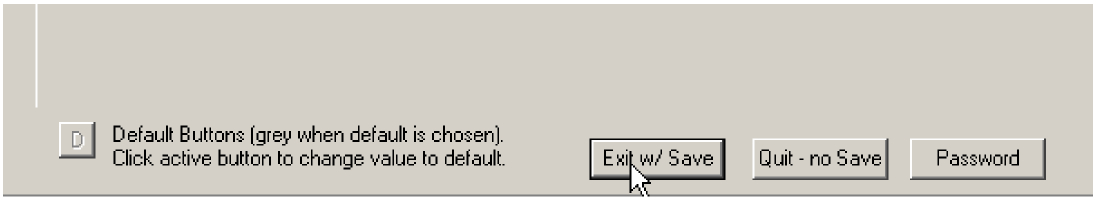
When you first run Caesar II program and making new calculation, you need to be careful some noted as below
a. Unit System
-Checking unit
For example: You want to use unit file named TRAINING.FIL for your calculation note, you need to check before proceed input data.
From Tools menu, select Configure/Setup



Then select Database Difinitions In Units File Name Field, select file name of unit system (like: TRAINING.FIL in this example)



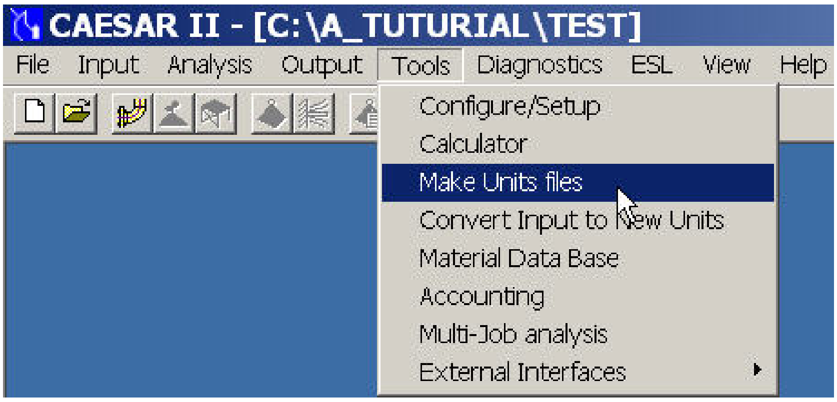
Then click Exit w/save if you want to save changed settings, otherwise, click Quit-no save



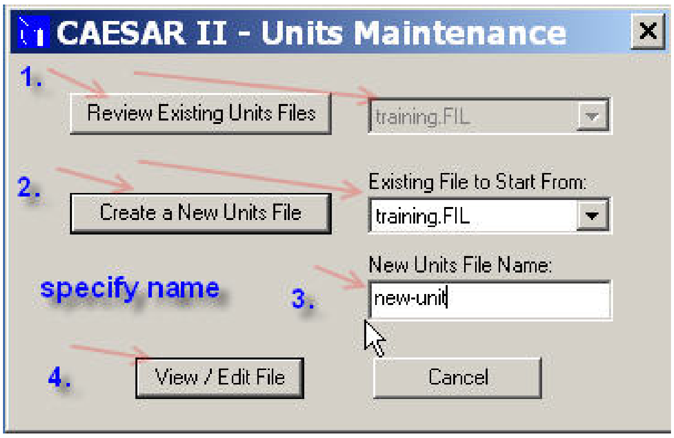
- Making unit

If you want to make new unit file name, follow steps below:

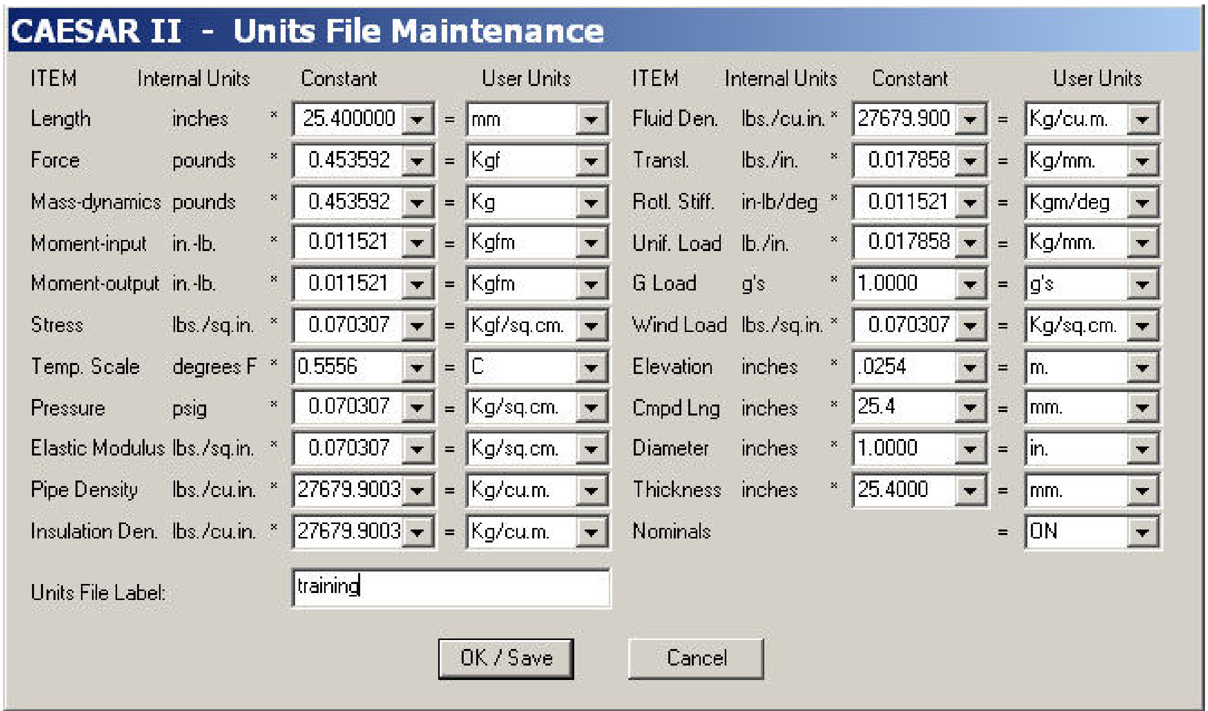
From Tools menu, select Make Units files



Follow 4 steps as shown be low:



From appeared spread, make change anything you want even Units File Label then click Ok/Save

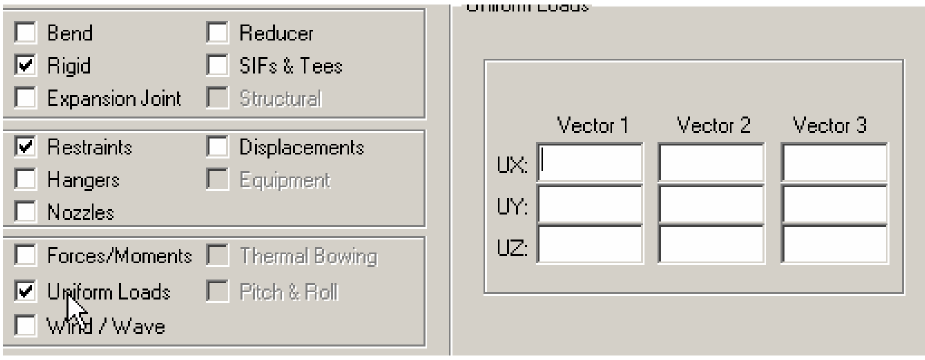


b. Uniform load

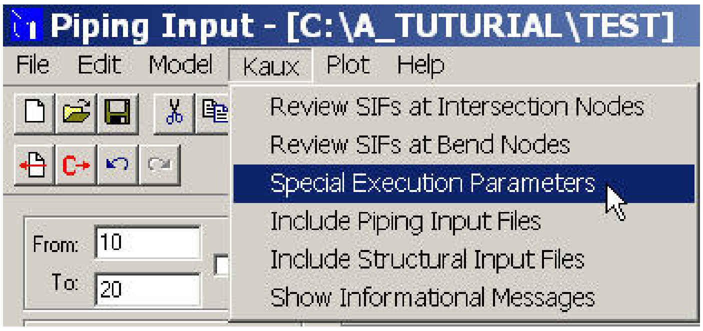
If you select wrong unit file and wrong uniform load, you will face problem like stress over or overload and it takes a lot of time to solve these.

After you correcting unit file name using for your calculation note, you need to check uniform load.
Base on your project requirement, you will know value for uniform load in this example we will take uniform load as below
GX=0.05
GZ=0.05
So, how can we check these one

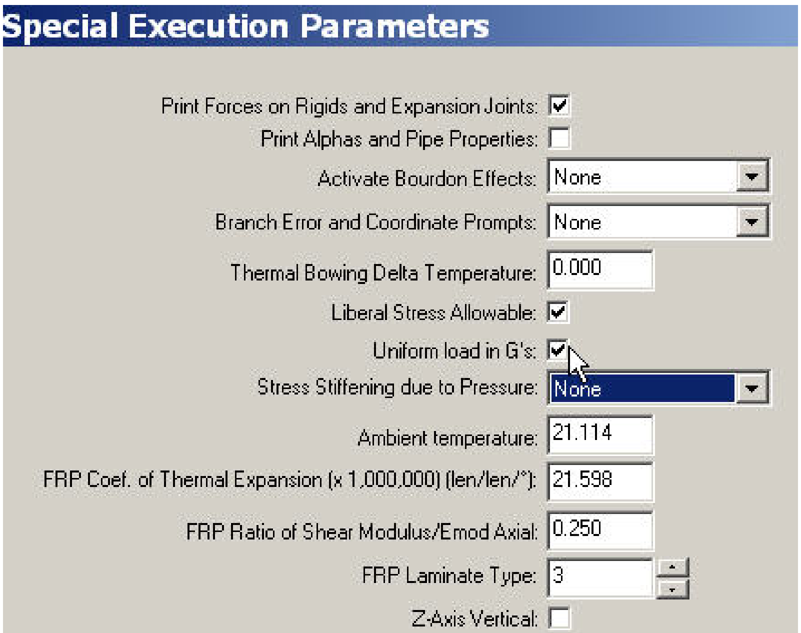
In Spread sheet, tick Uniform Loads
You see, Caesar II default by UX, UY, UZ (Not GX, GY, GZ as we want)



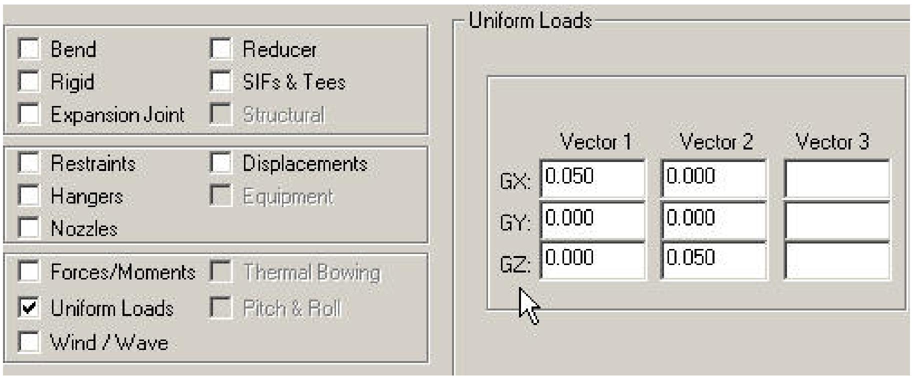
Please following steps below
From Kaux menu, Select Special Excution Parameters



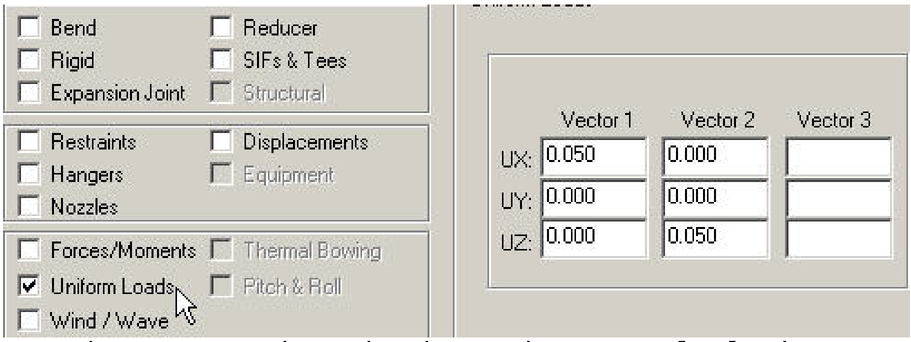
Tick Uniform load in G's



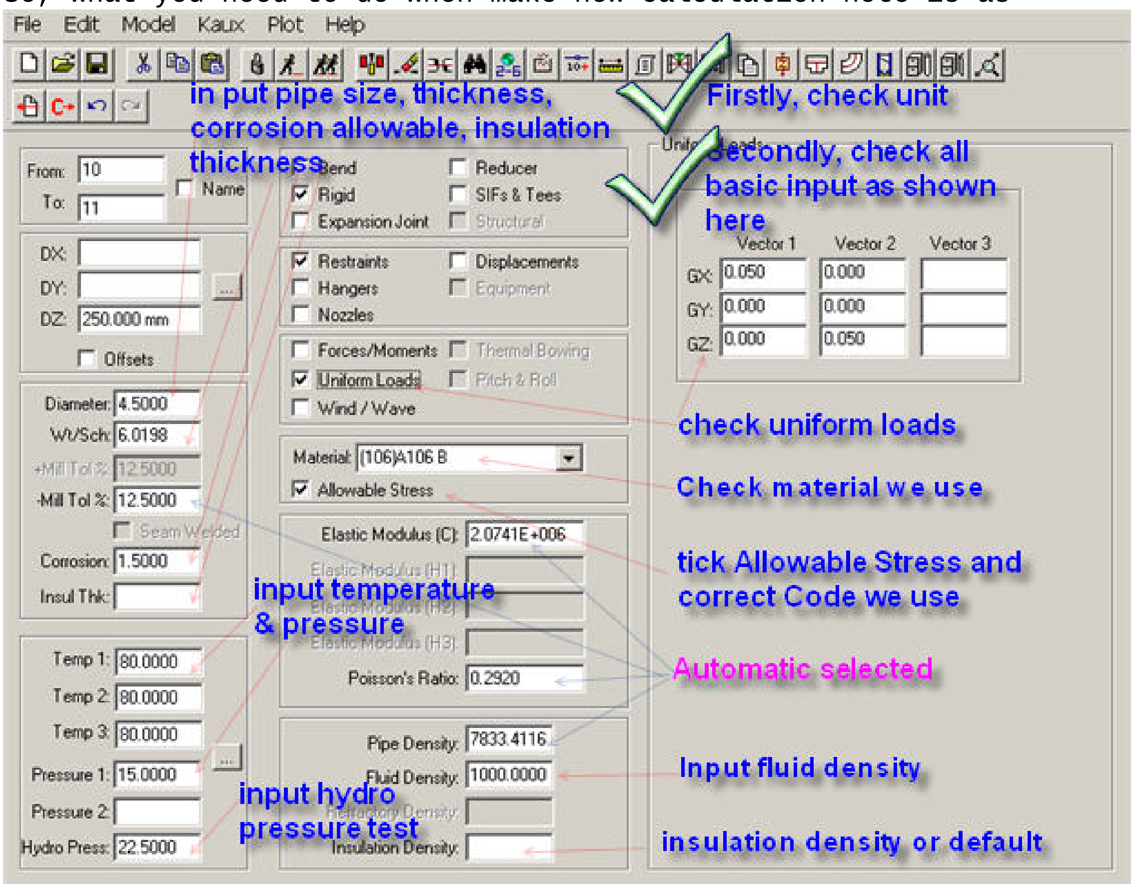
Then input value we have (in this example, we use GX=0.05, GY=0, GZ=0.05 See piture)



If your project require using UX, UY, UZ instead of GX, GY, GZ then you need to input your value as requirement and check these carefully
(You need to uncheck / UN Tick Uniform load in G's in Special Execution Parameters above)
For Example



So, what you need to do when make new calculation note is as



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If you are interested in piping, please visit http://www.azpiping.com or http://www.azpiping.com/guide for more details

Any comments any suggestion, please visit http://www.azpiping.com/guide/

Noted:
-This is first revision made on 16-Oct-2006
-This report will be updated in http://www.azpiping.com/pipe-stress-analysis-reports.htm

Please visit http://www.azpiping.com/pipe-stress-analysis-reports.htm to check update

Thank you for reading