User's guide to StackSizer

1 Installation

1. Supported compilers: gcc and MSVS
2. Prerequisite: EIGEN3, which is available at
   http://eigen.tuxfamily.org/index.php?title=Main_Page
3. Unzip the source code of StackSizer and EIGEN3 and add the directory of EIGEN3 to the compiler's include path.
4. Turn on the compiler's OpenMP support (optional)

2 Key functions

1. Ply properties are defined by the fields:
   ply.Ex = 154.e3;
   ply.Ey = 8.5e3;
   ply.Gxy = 4.2e3;
   ply.MIUxy = 0.35;
   ply.thick = 0.184;
2. Allowable Tensional strain is given by the function
   double epsi_al_t(struct Laminate plate)

3. Allowable compressive strain is given by the function
   double epsi_al_c(struct Laminate plate)
4. Compressive postbuckling coefficient, which is defined as the allowable compressive buckling load over the ultimate load, is given by:
   double PB_coef_c(struct Laminate plate)
5. Shear postbuckling coefficient, which is defined as the allowable shear buckling load over the ultimate load, is given by:
   double PB_coef_s(struct Laminate plate)
6. Prototypes of buckling functions are declared in the header file Composite.h, the following functions are available:

struct PlateBuckleState PlateBuckling_UC_F_SCSC_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_UC_F_SSSS_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_UC_F_CCCC_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_UC_C_SSSS_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_BC_F_SSSS_Ortho(struct Laminate plate, double k);
struct PlateBuckleState PlateBuckling_UC_F_SBSB_Ortho(struct Laminate plate, double EA, double EI, double GJ);
struct PlateBuckleState PlateBuckling_UC_F_SSSF_Ortho(struct Laminate plate);

```
struct PlateBuckleState PlateBuckling_UC_F_SESF_Ortho(struct Laminate plate, double C0);
struct PlateBuckleState PlateBuckling_UC_F_SESE_Ortho(struct Laminate plate, double C0);
struct PlateBuckleState PlateBuckling_S_F_CCCC_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_S_F_CCCC_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_S_F_SSSS_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_S_F_SCSC_Ortho(struct Laminate plate);
struct PlateBuckleState PlateBuckling_NS_F_SSSS_Aniso(struct Laminate plate, struct PlateLoad pl);
```

A function name follows:

```
struct PlateBuckleState PlateBuckling_SEG1_SEG2_SEG3_SEG4(struct Laminate plate, foo...);
```

Tab naming ruler

SEG1 Load type	UC	Unidirectional compression
	BC	Bi-directional compression
	S	Shear
SEG2 Plate type	F	Flat plate
	C	Curved plate
SEG3 Boundary condions	S	Simply Support
	C	Clamp support
	F	Free
	B	Restrained by a beam
	E	Rotational spring
SEG4	Ortho	Orthotropic, neglecting D_{16},D_{26}
	Aniso	Anisotropic, taking in to account D_{16},D_{26}

3 Input file

The input file is composed by the following 5 parts:

1) Line1:

N_{bay}, $N_{subcase}$, N_{size}, N_{lock}, MS

	Type	Meaning
N_{bay}	int	Number of laminate bays
$N_{subcase}$	int	Number of subcases
N_{size}	int	Number of input lines for defining bay sizes
N_{lock}	int	Number of input lines for defining bay thickness
MS	float	Target margin of safety

2) Line2:

N_{round}, N_{inner_loop}, N_{outer_loop}, $Switch_{trim}$

	Type	
N_{round}	int	Number of rounds

N_{inner_loop}	int	Outer loop size of each round
N_{outer_loop}	int	Inner loop size within each outer loop
$Switch_{trim}$	int	Switch to open 90/0 flip

3) Load define part

$N_{subcase}$ input blockes, each block contains 1+N_{bay} lines. The block for each subcase is:

SUBCASE: SUBCASEID				(1 line)
ElemID 1	N_{xx}	N_{yy}	N_{xy}	
ElemID 2	N_{xx}	N_{yy}	N_{xy}	
ElemID 3	N_{xx}	N_{yy}	N_{xy}	(N_{bay} lines)
ElemID 3	N_{xx}	N_{yy}	N_{xy}	
...	...	...	...	
ElemID N_{bay}	N_{xx}	N_{yy}	N_{xy}	

The symbols are defined as:

	Type	Meaning
SUBCASEID	int	Subcase id
ElemID	int	Element id
N_{xx}	double	In-plane normal force along the X-direction with the unit of N/mm
N_{yy}	double	In-plane normal force along the Y-direction with the unit of N/mm
N_{xy}	double	In-plane shear force with the unit of N/mm

4) Size define part

Consist of N_{size} lines, in each line,

ElemID$_1$: ElemID$_2$:PACE *a b*

ElemID$_1$	int	Start element id
ElemID$_2$	int	End element id
PACE	int	stride
a	double	Plate length in mm
b	double	Plate width in mm

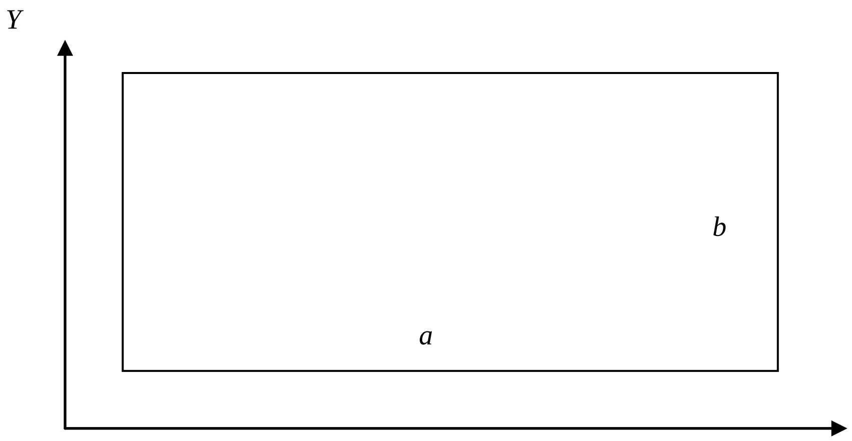

Fig: sizes of a plate

This line attributes *a*-by-*b* to elements $ElemID_1$, $ElemID_1$+PACE, $ElemID_1$+2PACE, $ElemID_1$+3PACE,..., $ElemID_2$.

If the stride is 1, then use:

$ElemID_1$: $ElemID_2$:PACE *a b*

If only one bay is to be defined, then use:

$ElemID_1$ *a b*

5) Thickness define part

If certain bays are to be excluded from the optimization, then its thickness should be fixed a priori. There are N_{lock} lines defining fixed bay thickness, the formation is:

$ElemID_1$: $ElemID_2$:PACE *num*

or

$ElemID_1$: $ElemID_2$ *num*

or

$ElemID_1$ *num*

Num is the number of layers.

6) Connection define part

Connection relations are defined in pairs till the end of the input file. For example, the connection of the following bays are given as:

1 2

1 3

2 4

3 4

1	2
3	4

Fig A sample with 4 zones

4 Result

```
Plate No.:   1, FEM ELEMENT ID:  01, RANK:        1, Subcase:  10, Layers:  12, M.S:       2.39, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   2, FEM ELEMENT ID:  02, RANK:        2, Subcase:  10, Layers:  12, M.S:       2.36, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   3, FEM ELEMENT ID:  03, RANK:        3, Subcase:  10, Layers:  12, M.S:       2.35, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   4, FEM ELEMENT ID:  04, RANK:        4, Subcase:  10, Layers:  12, M.S:       2.35, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   5, FEM ELEMENT ID:  05, RANK:        5, Subcase:  10, Layers:  12, M.S:       2.35, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   6, FEM ELEMENT ID:  06, RANK:        6, Subcase:  10, Layers:  12, M.S:       2.35, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   7, FEM ELEMENT ID:  07, RANK:        7, Subcase:  10, Layers:  12, M.S:       2.35, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   8, FEM ELEMENT ID:  08, RANK:        8, Subcase:  10, Layers:  12, M.S:       2.36, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:   9, FEM ELEMENT ID:  09, RANK:        9, Subcase:  10, Layers:  12, M.S:       2.38, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:  10, FEM ELEMENT ID:  10, RANK:       10, Subcase:  10, Layers:  12, M.S:       2.01, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:  11, FEM ELEMENT ID:  11, RANK:       11, Subcase:  10, Layers:  12, M.S:       2.40, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:  12, FEM ELEMENT ID:  12, RANK:       12, Subcase:  11, Layers:  12, M.S:       2.27, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:  13, FEM ELEMENT ID:  13, RANK:       13, Subcase:  11, Layers:  12, M.S:       1.79, FailMode: 1,  45, -45,    ,  90,    ,
Plate No.:  14, FEM ELEMENT ID:  14, RANK:       14, Subcase:  14, Layers:  12, M.S:       1.04, FailMode: 2,  45, -45,    ,  90,    ,
Plate No.:  15, FEM ELEMENT ID:  15, RANK:       15, Subcase:  10, Layers:  12, M.S:       0.82, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  16, FEM ELEMENT ID:  16, RANK:       16, Subcase:  10, Layers:  12, M.S:       1.34, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  17, FEM ELEMENT ID:  17, RANK:       17, Subcase:  10, Layers:  12, M.S:       1.41, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  18, FEM ELEMENT ID:  18, RANK:       18, Subcase:  10, Layers:  12, M.S:       1.33, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  19, FEM ELEMENT ID:  19, RANK:       19, Subcase:  10, Layers:  12, M.S:       1.22, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  20, FEM ELEMENT ID:  20, RANK:       20, Subcase:  10, Layers:  12, M.S:       1.08, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  21, FEM ELEMENT ID:  21, RANK:       21, Subcase:  10, Layers:  12, M.S:       0.78, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  22, FEM ELEMENT ID:  22, RANK:       22, Subcase:  10, Layers:  12, M.S:       0.73, FailMode: 3,  45, -45,    ,  90,    ,
Plate No.:  23, FEM ELEMENT ID:  23, RANK:       23, Subcase:  10, Layers:  12, M.S:       0.50, FailMode: 3,  45, -45,    ,  90,    ,
```

Fig Screen shot of the example result