ELLIPSE PLAN HYPERBOLIC PARABOLOID CABLE-NET FRAME

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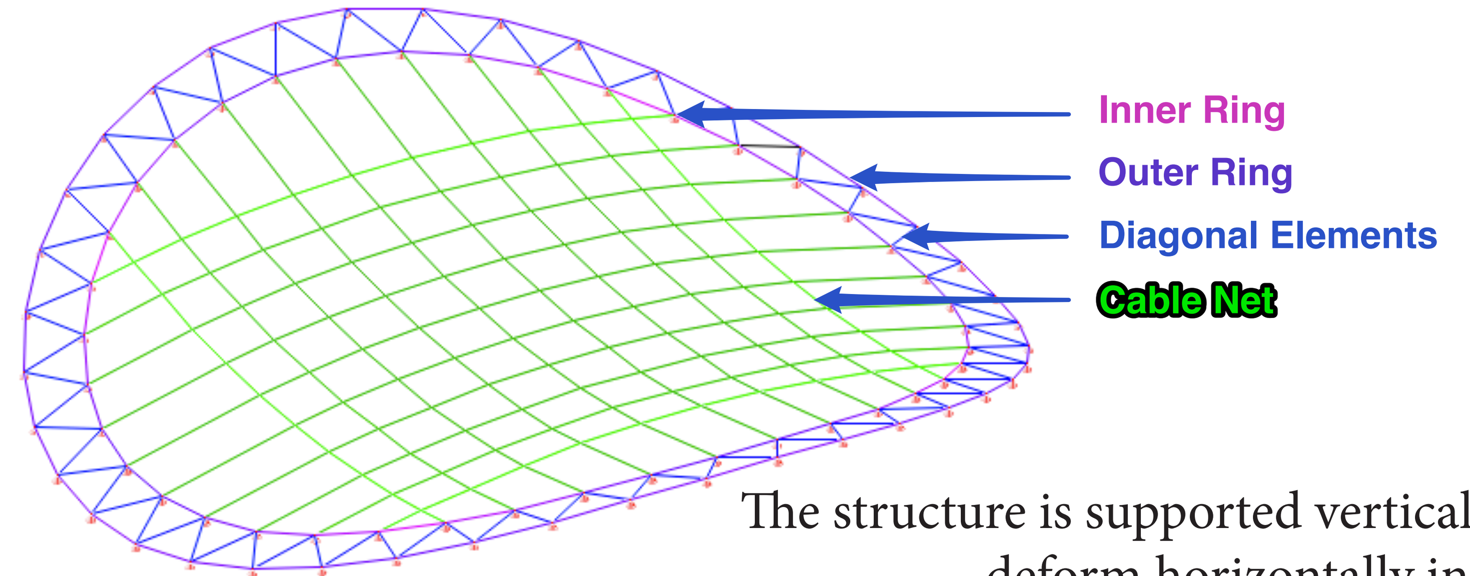
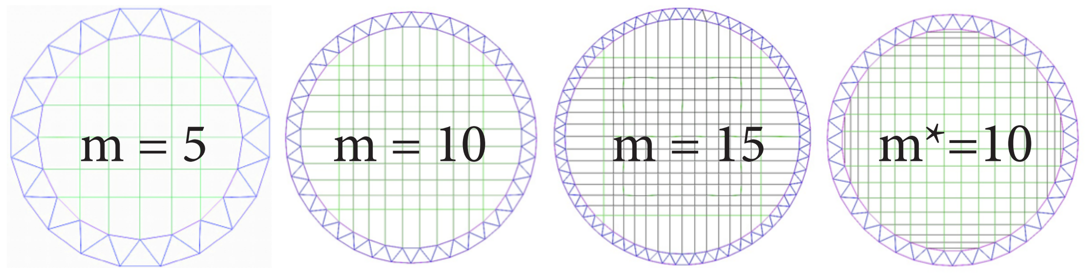
WHAT IT IS



The structure is supported vertically and can deform horizontally in x-y plane.



There are more cables per direction as m increases. (* special cable layout)

WHAT THE KEY ISSUES WERE

How does the frame deform axially due to pre-strain in the cables?

How to arrive to the desired final shape if the initial shape is unknown?

What does truss to cable cross sectional area ratio do to the axial stiffness?

How does the number of cables embedded affect the axial stiffness?

What is the benefit of allowing for the cables to slide instead of restraining?

How do the two forms cable arrangement differ in terms of axial stiffness?

WHAT WAS DONE ABOUT IT

A program was written on the Processing programming environment.

A modified dynamic relaxation algorithm was used.

Unknown initial geometry from the known final geometry was then possible.

It was also possible to determine the final stress state due to a defined pre-stress.

A function to account for sliding of cables was incorporated.

Solving these enabled the problems identified above to be tackled.

WHAT IS NEXT

Does varying the truss and cable elastic moduli ratio do?

What does varying the aspect ratio in x and y axis do?

What does varying frame curvature in x, y and z axis do?

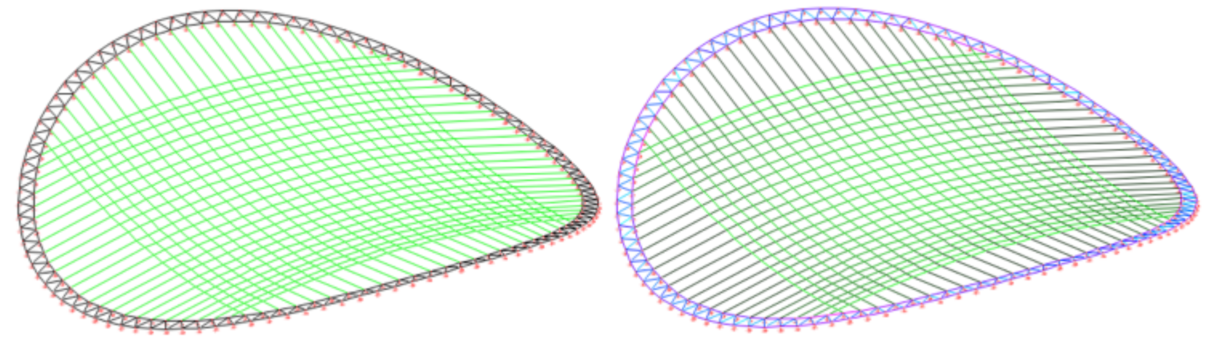
What does introducing dead and imposed load do?

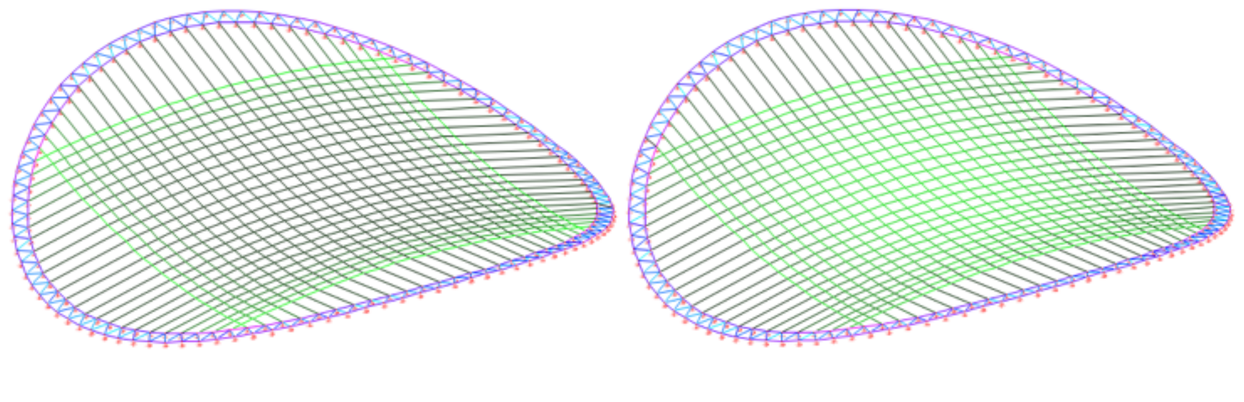
What does incorporating thermal differences?

What relationship does cable pre-strain have maximum stresses?

How closely do the results here resemble reality?

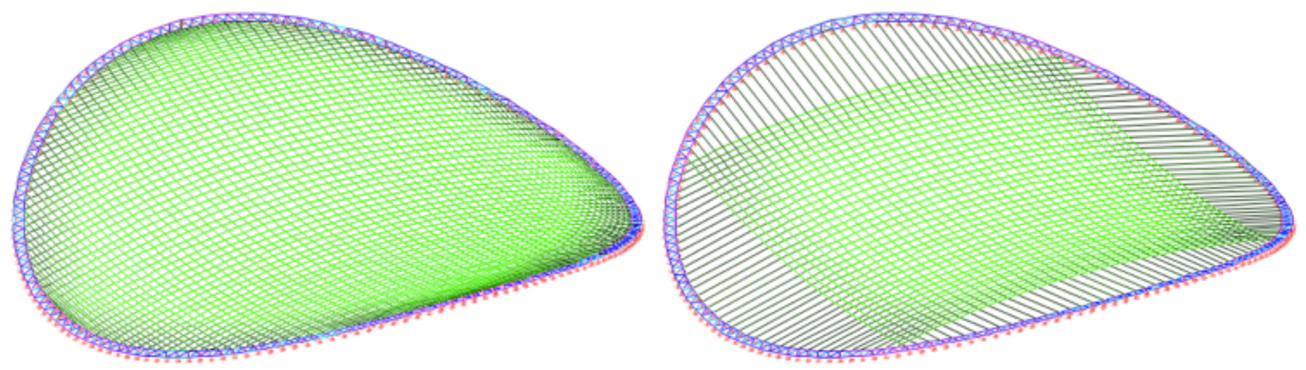
The modified algorithm determines the shape of the initial geometry (left) from the defined final geometry (right)

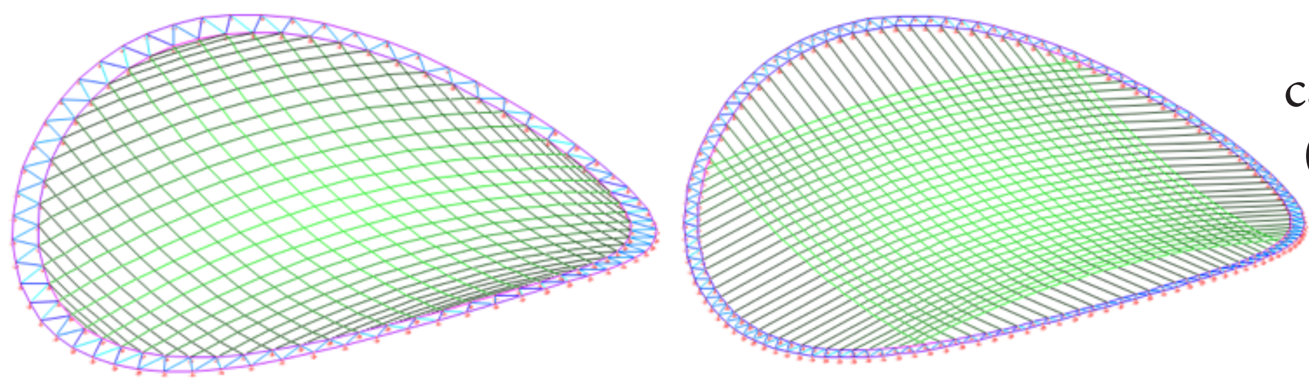




The difference between the stress distribution when the cables are allowed to slide (left) and when they are not (right)

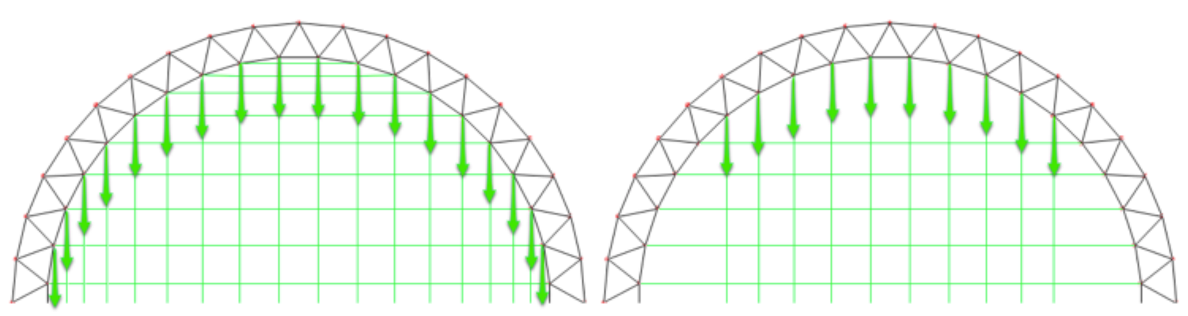
The algorithm determines the ordinary stress distribution (left) and the final geometry (right)

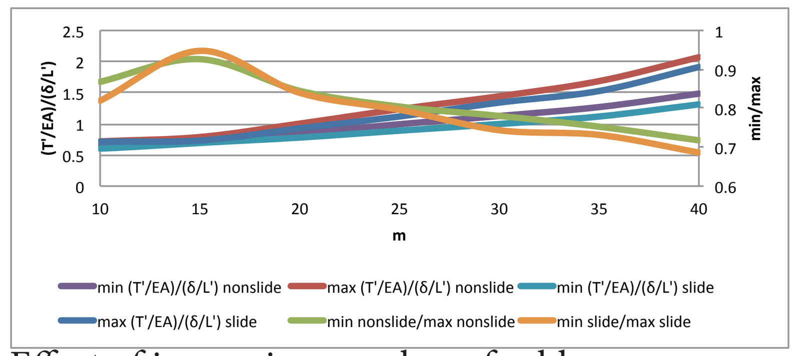




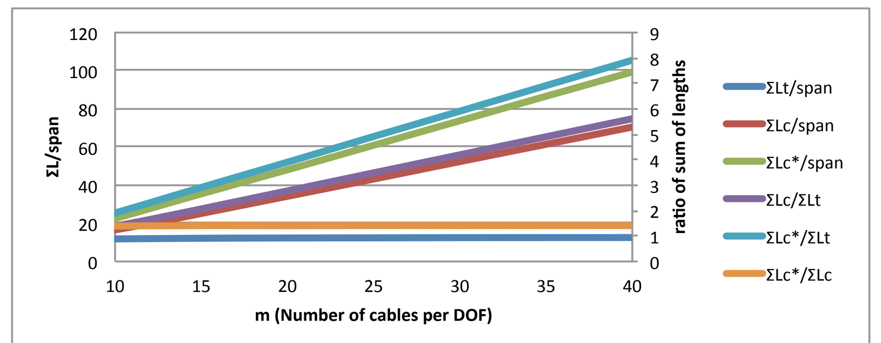
The stress dribution when the special case of cable layout (left) has the same number cables as an ordinary cable layout (right)

Arch analogy to describe a far more uniformly loaded arch for the special case (left) vs. only middle half loaded arch for the ordinary case (right)

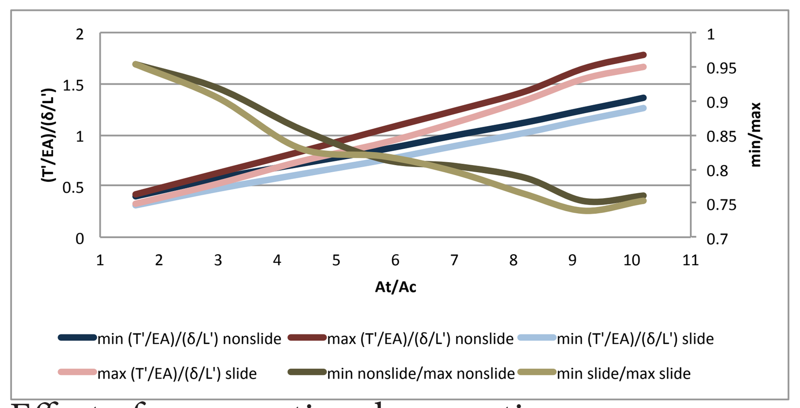




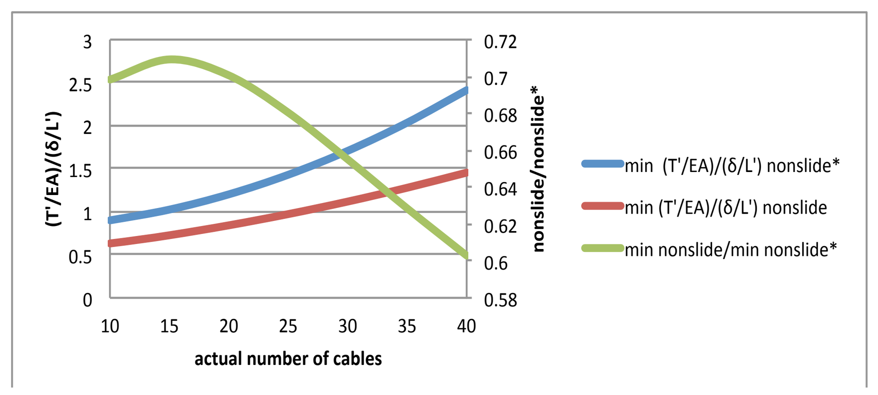
Effect of increasing number of cables m



Material required with increasing m



Effect of cross sectional area ratios



Comparison of special and ordinary layout stiffness

WHAT WAS FOUND

Increasing the truss to cable cross-sectional ratio makes the frame stiffer.

Generally, there is a reduction in stiffness with increasing cable prestrain.

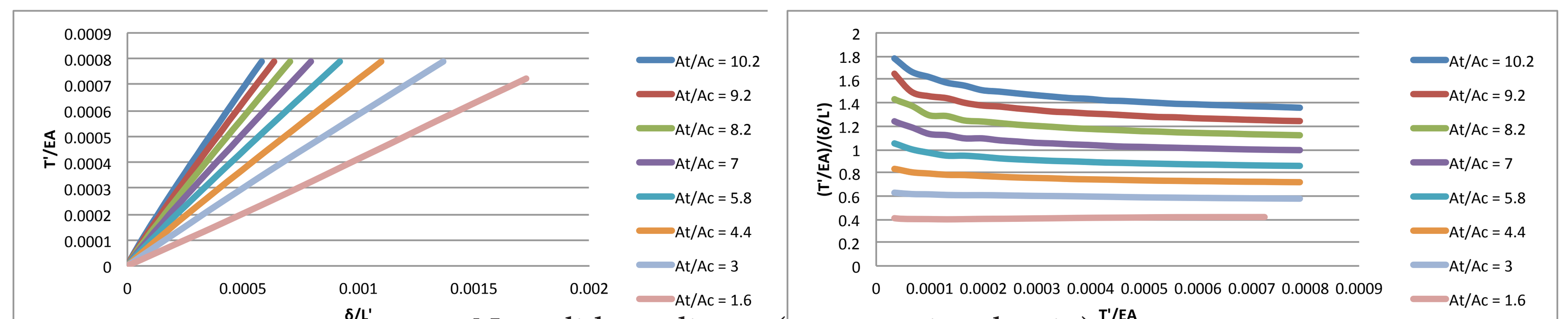
A high truss to cable cross-sectional ratio fails due to limit imposed by cable cross sectional capacity. A low ratio fails due to limit imposed by truss cross sectional capacity.

Increasing the number of cables embedded within the frame leads to a greater uniformity in force transfer, giving a stiffer frame.

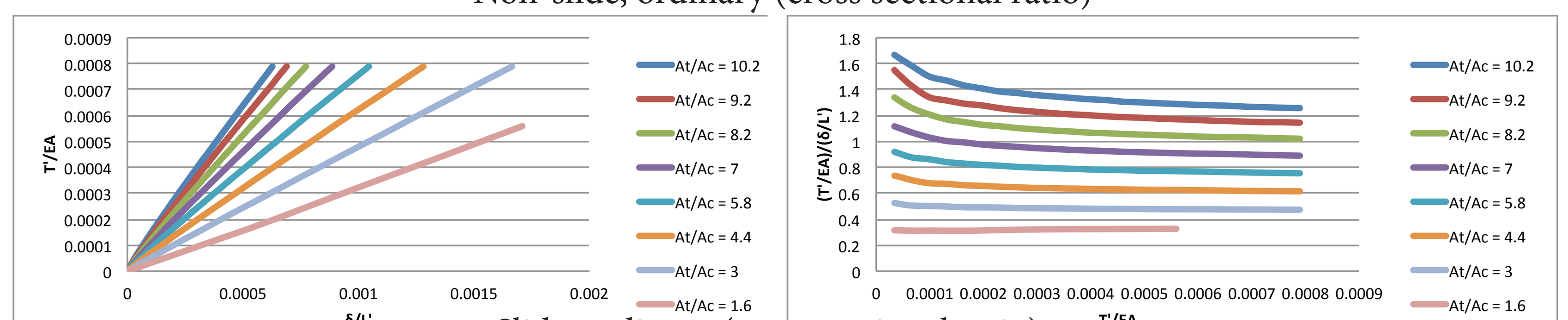
Restraining the cables at the intersection nodes also leads to a stiffer frame due to an even redistribution of initial pre-strain across all the cable members as the boundary shrinks.

It was found that a special case of cable arrangement is stiffer when there are additional cables.

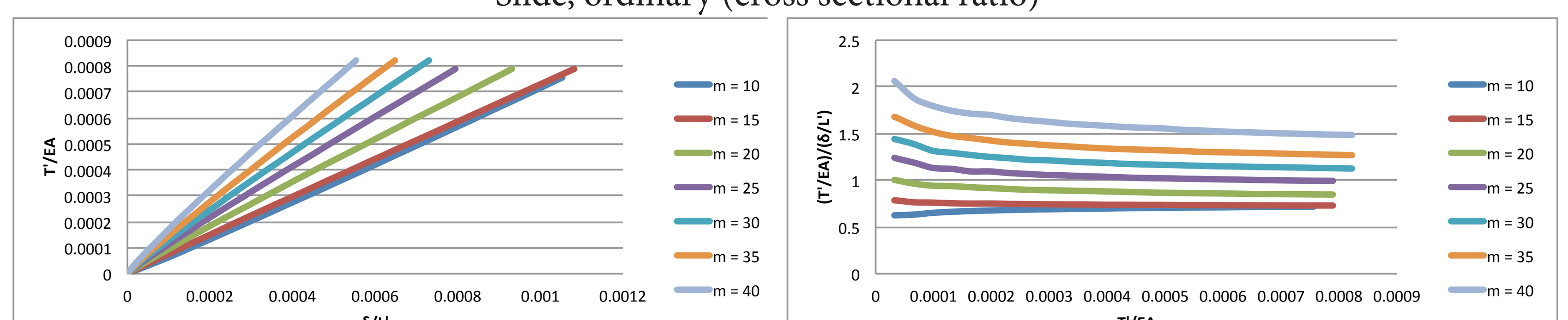
It is also stiffer where there are the same number of cables per direction as an ordinary frame due to greater uniformity in transfer of forces to the boundary truss in the same way arches with UDL deform less.



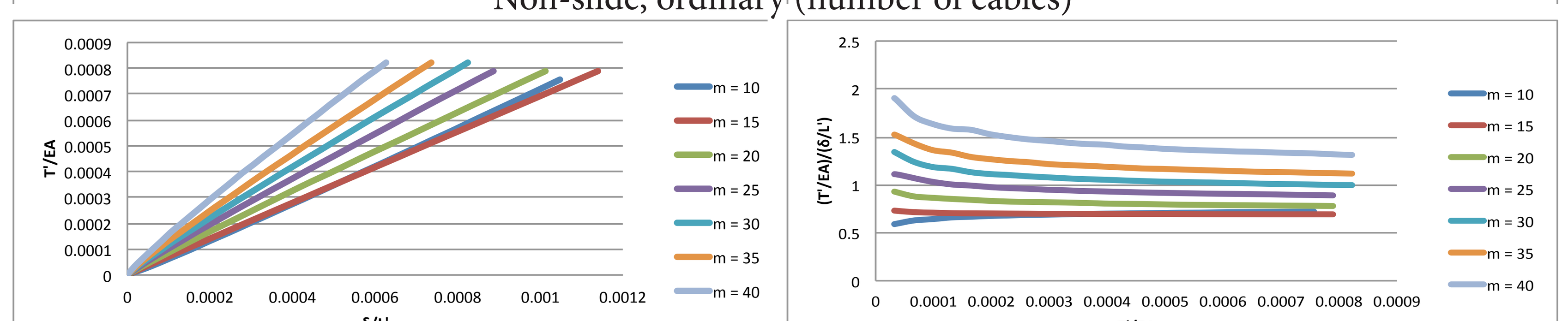
Non-slide, ordinary (cross sectional ratio)



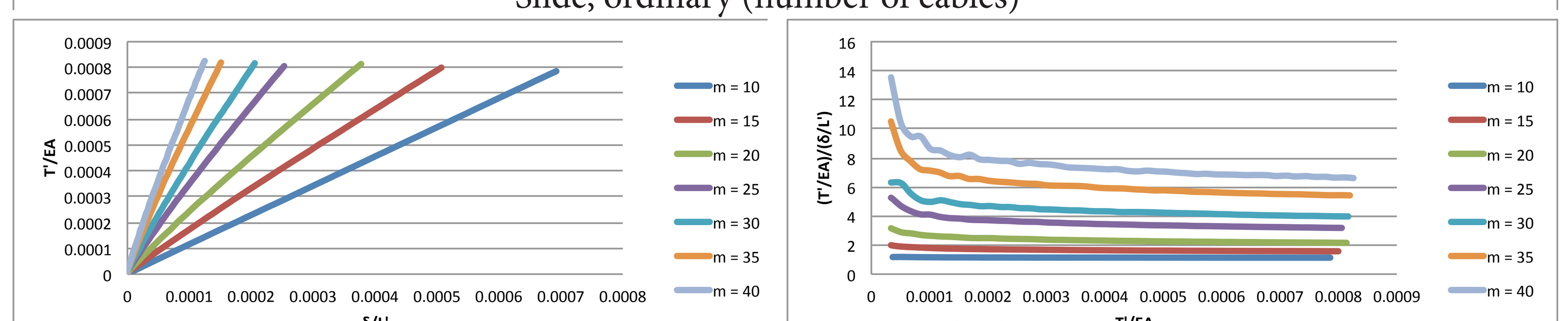
Slide, ordinary (cross sectional ratio)



Non-slide, ordinary (number of cables)



Slide, ordinary (number of cables)



Non-slide, special (number of cables)