

MSC Nastran U* Toolkit

U* index enables the visual understanding of the load transfer path of the entire structure

MSC Nastran U* Toolkit developed by the collaborative project with Keio University and MSC Software, is a plug-in for MSC Nastran and the release of this toolkit was lead by MSC Software Japan. U* (U Star) index enables the visual understanding of the load transfer path of the entire structure, and the utilization to weight saving and high rigidity is expected.

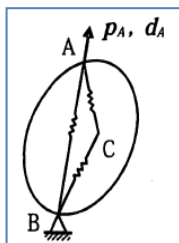
In a general structural analysis, it evaluates structural strength using stress or strain. However, high stress and strain values are shown in local stress concentration area, such as constraint point, load point, and circular hole circumference, and there are quite a few cases where it is difficult to grasp the load transfer path of the entire structure.

In response to such difficulty, Kunihiro Takahashi, a professor emeritus at Keio University introduced the new index U* for the load transfer path. By using this new index named U*, it becomes possible to understand the load transfer path and the degree of connection of the structure, and the utilization to weight saving and high rigidity is expected.

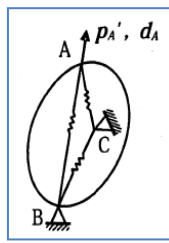
With the conventional method, calculation of U* value required an analysis which included a vast amount of load cases, and analysis time was excessively-long. Now, in addition to the new algorithm developed by Keio University and by taking advantage of the high speed analysis technology of MSC substantial time can be saved, and use in the usual design cycle is enabled.

What is U*

U* is the index about the load transfer path which has been introduced by Keio Univ. Prof. Takahashi. It is a new index to express the connectivity between the loading point and an arbitrary point in a structure.



U:
strain energy of
elastic structure



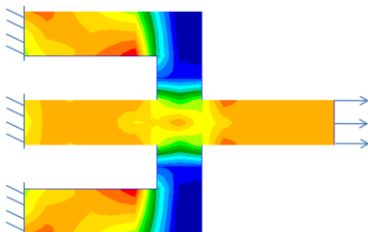
U' :
strain energy
when C is fixed.
(C: arbitrary point)

$$U^* \equiv 1 - \left(\frac{U'}{U} \right)^{-1}$$

Validation example with simple model

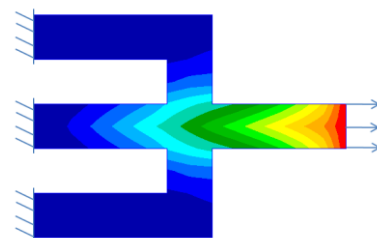
Center board: thick, Up & down board: thin \Rightarrow Most part of the load is sustained by the center board.

Evaluation by stress



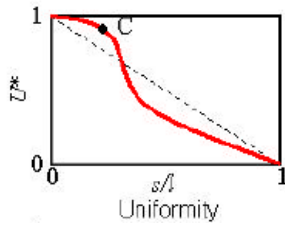
Stress is concentrate equally in three board.
Ambiguous to which the stress is transferred.

Evaluation by U* value

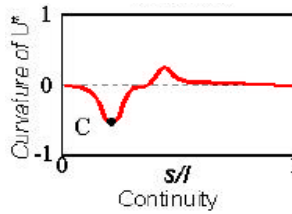


Understand the load transfer path through the
center board

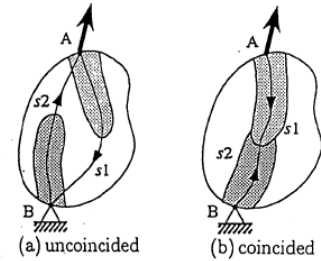
U* Evaluation Index



- (1)U* Uniformity in distribution
- horizontal axis: path length
 - longitudinal axis: U*
 - Uniformly-varying like broken line is desirable



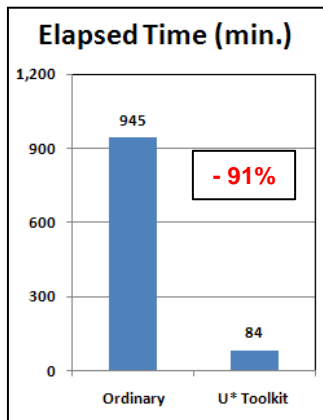
- (2)U* Continuity in distribution
- Longitudinal axis: U* curvature
 - Flat line is desirable



- (3)Path Consistency
- s1: from A to B
 - s2: from B to A
 - Coincidence of two courses is desirable

Performance Validation Example

Sample Model
· Grid: 170,000



Comparison with topology optimization

Topology optimization

- Topology optimization can output optimal material distribution.
- In some case, material distribution shows load path.

U* distribution

- U* shows precise information about load path with current design
- U* results encourage freewheeling thinking of designers
- In many cases, it is very difficult to apply topology optimization for real structure

U* Toolkit Package

- U* calculation formulation is included
- Algorithm for cost reduction is mounted
- U* Post for path search from U* distribution

Applied Area

- Industry: Automotive, Heavy Equipment, Machinery
- Evaluation of structural strength, reinforcement review
- Comprehend structure-function, review load transfer mechanism
- Strength evaluation of machines at conveyance/circling time

Environment

OS	Windows Linux x8664
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