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Task

Optimization of fastener distribution during airframe assembly (*problem #1*)

Task was proposed by **Airbus SAS**

Task

For a given number *N* of fastening elements find the disposition of fasteners that gives the minimal probability of the gap *G* exceeding given level *Gmax*.

$$P\{G(x_1, ..., x_n) > G_{max}\} \to \min,$$
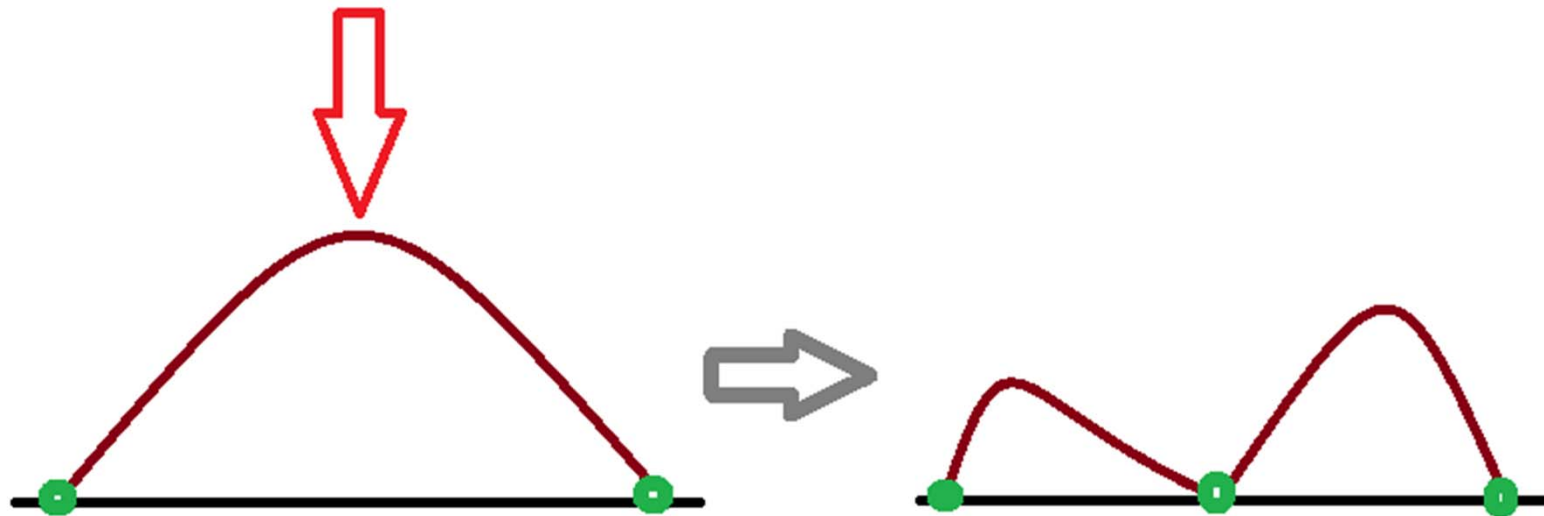
$$cstr : \sum_i x_i = N,$$

$$w.r.t. : \{x_i\}_{i=1,...n}, \quad x_i \in \{0, 1\},$$

Existing method

ASRP software

Position of next temporary fastener is determined according to maximum current gap

Formulation of the problem

Develop the method of finding the universal fastener disposition pattern with predefined boundary level of gap

Input

Disposition of holes for fasteners

Output

Disposition of temporary fasteners

Our assumptions

A. Every surface is made from homogeneous material (due to the non-availability of information about their structure)

B. Single fastener influences locally on surface

Proposed solution (1)

Distribution of temporary fasteners in junction area should be an periodical tracery
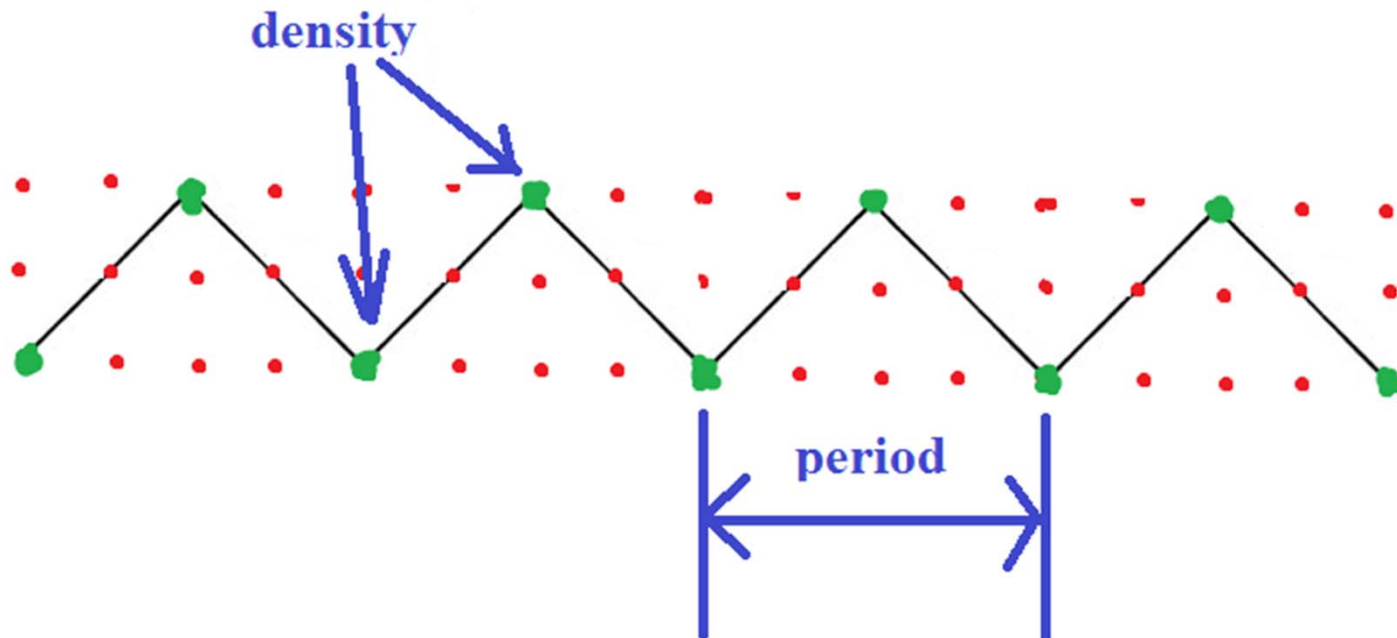
Our proposition: use "snake" tracery
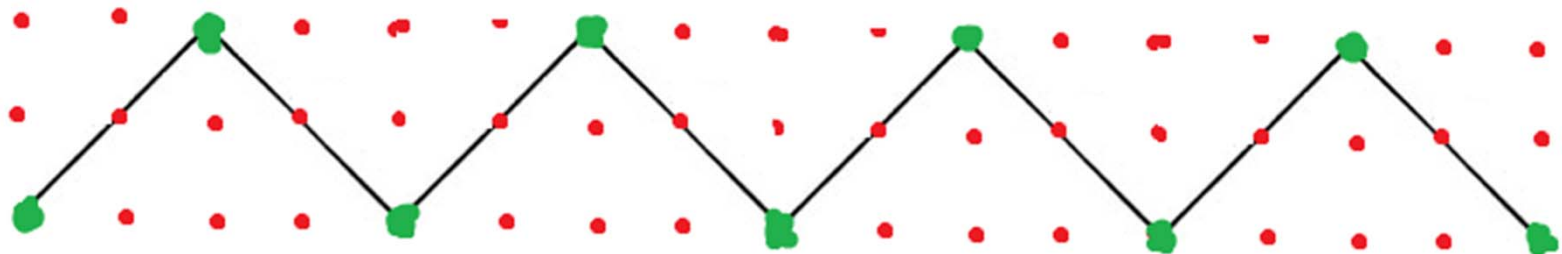
Proposed solution (II)

"Snake" has two parameters that can be varied:

- Period of tracery

- Density of fasteners on tracery

Proposed solution (III)

This parameters can be changed according to the information about the surface structure and properties of each material

Comparison of results

50 random generated sets of gaps

- Amplitude G=5

- Roughness Alpha= 0.0025
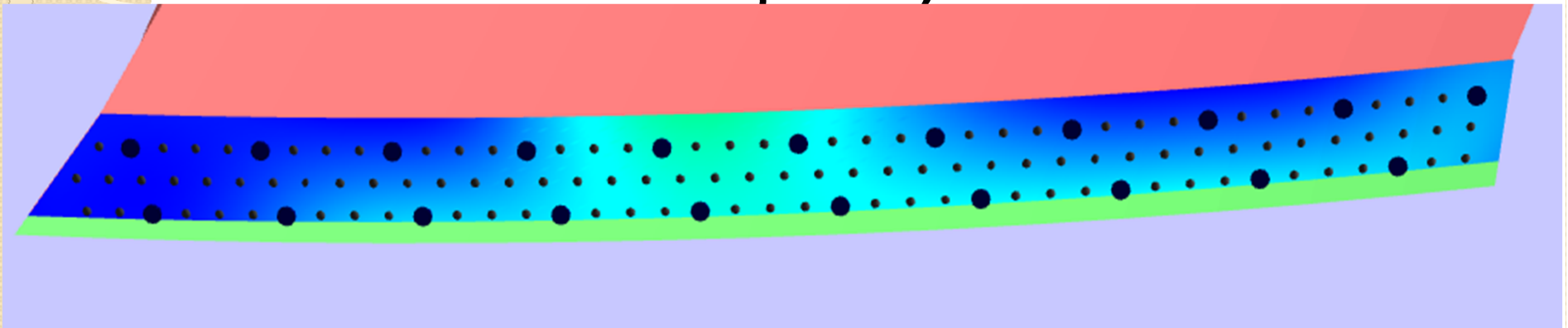
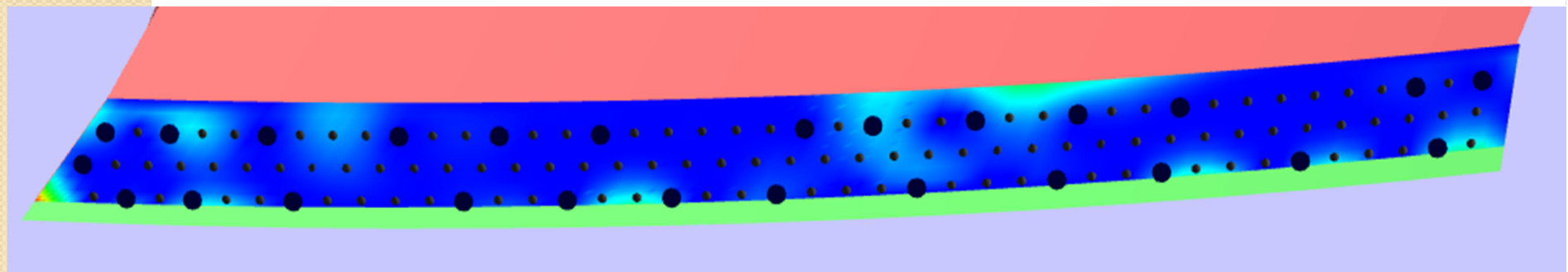## **Average maximum gap**

- "Snake" 0.62

- ASRP 0.35

Comparison of results

"Snake" – 21 temporary fasteners

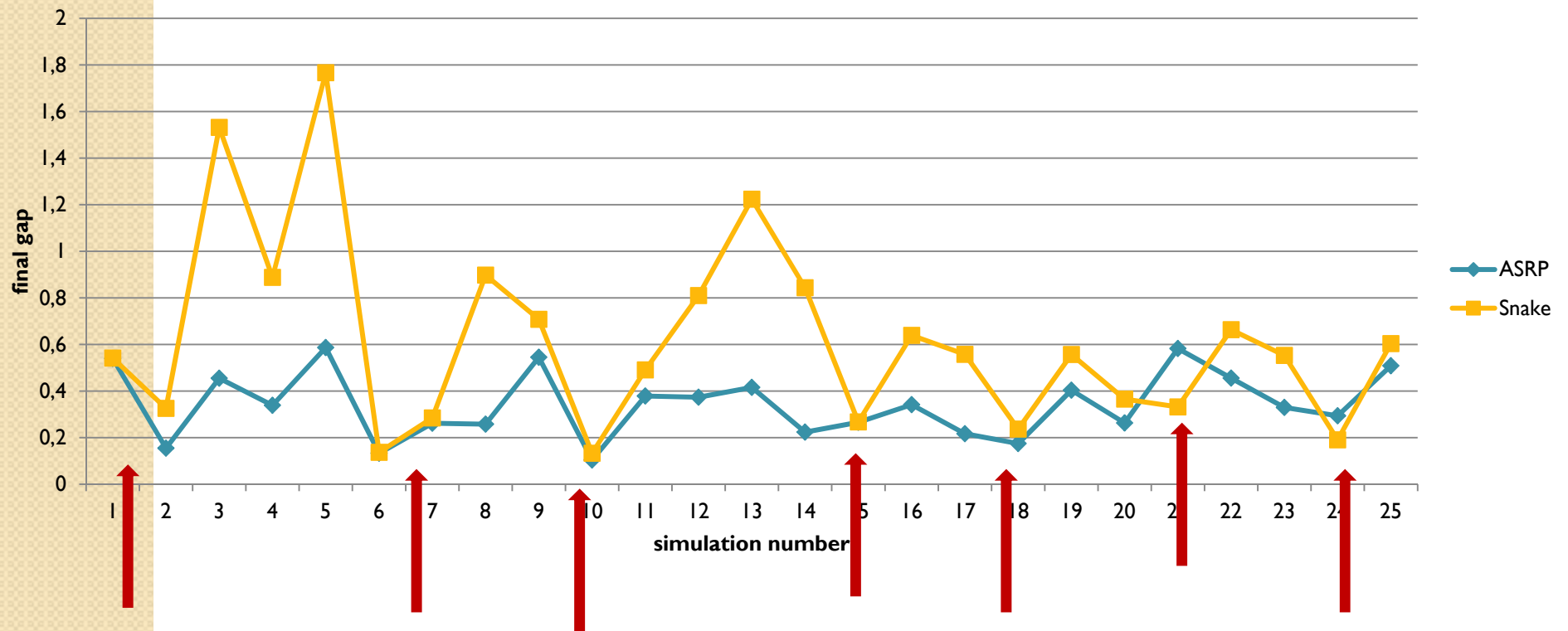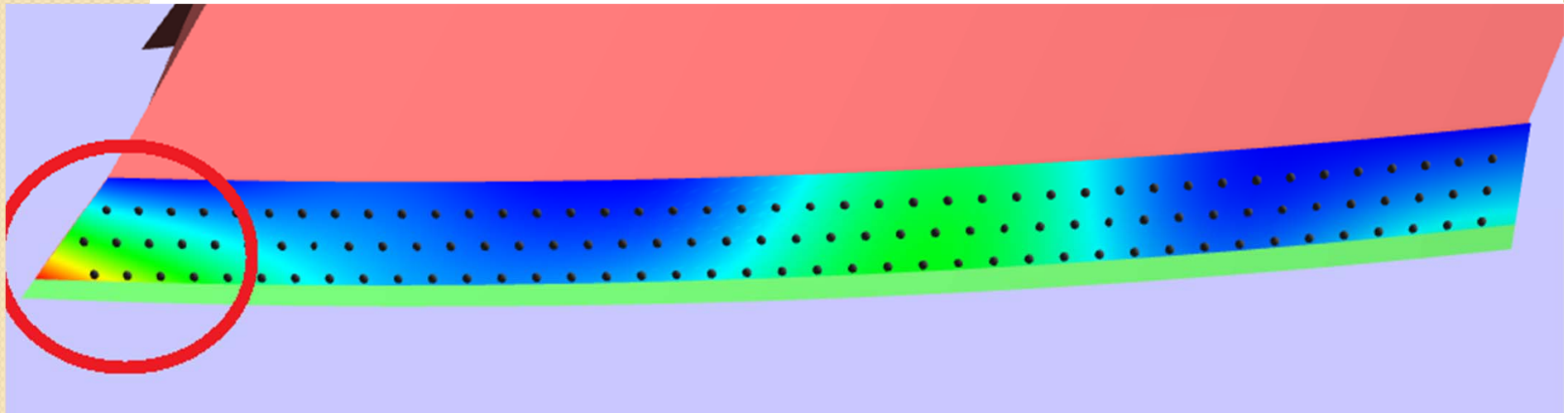## ASRP – 26 temporary fasteners

Comparison of results
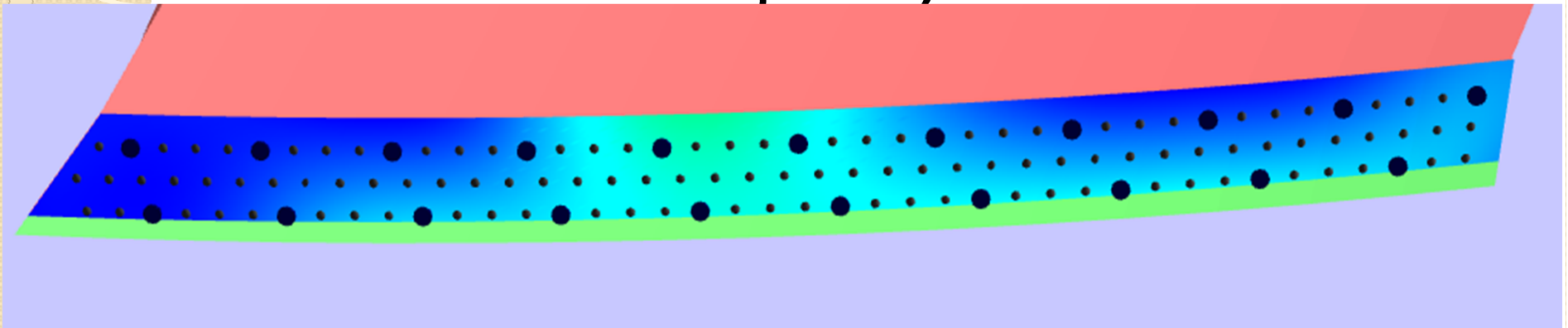
ASRP vs "Snake"

Comparison of results
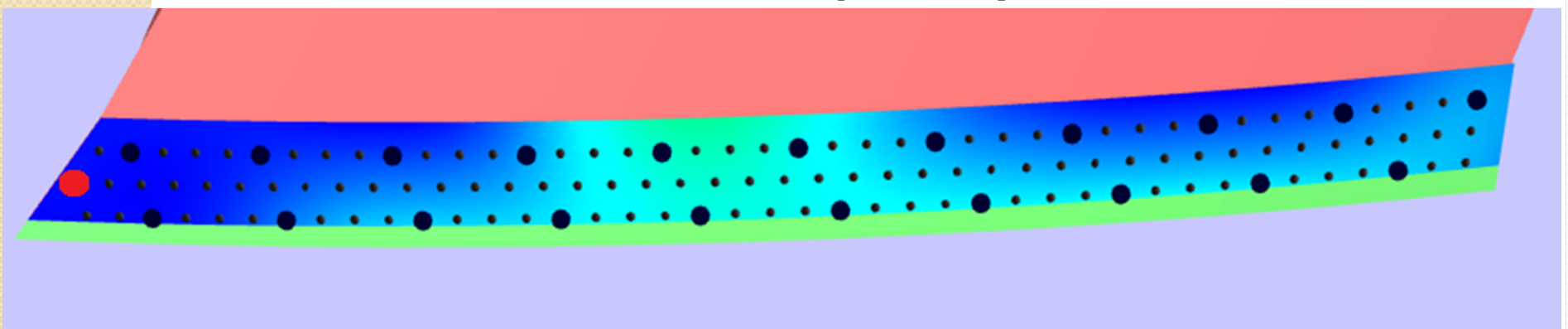
Major reason of difference in "snake"

Solution: additional fasteners at the unfixed corners

Comparison of results

"Snake" – 21 temporary fasteners
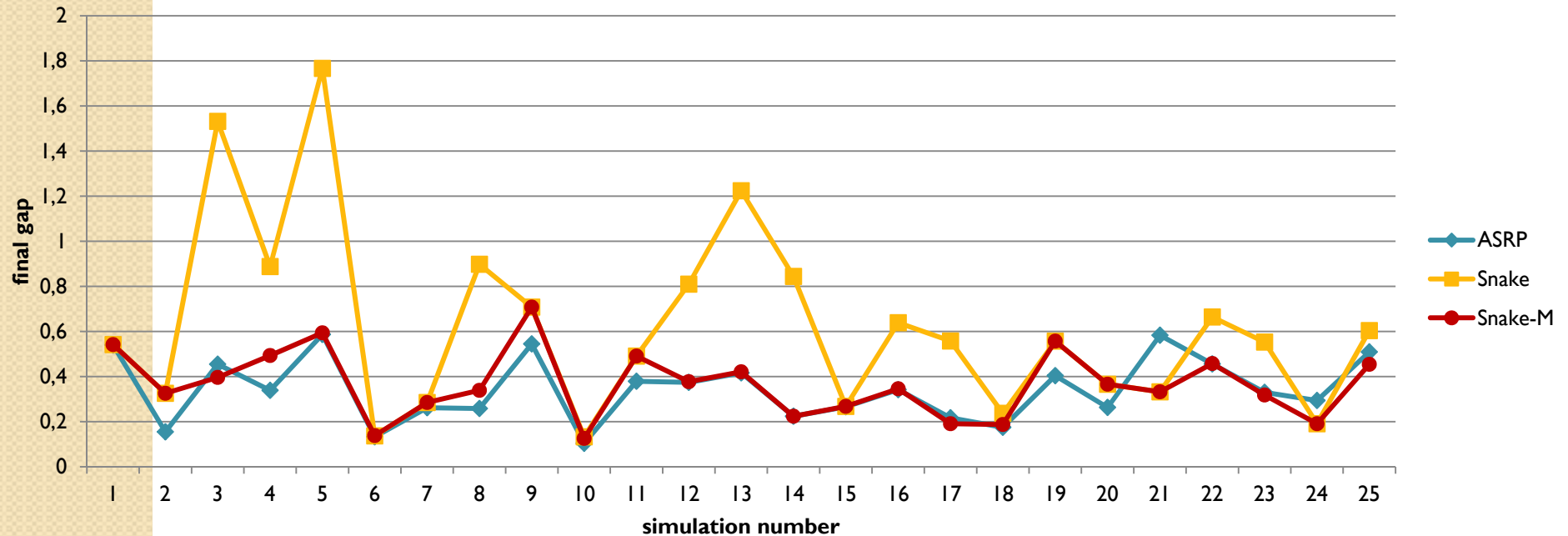

"Snake-M" – 22 temporary fasteners

Comparison of results

ASRP vs "Snake" vs "Snake-M"

ASRP – 0,35

Snake – 0,62

Snake-M – 0,37

Further development

Genetic algorithm can be used for optimization of general "snake" form to certain types of connected surfaces.

Also genetic algorithm can be used in current method realized in ASRP for detecting the position of the next temporary fastener (similar to solving the problem of finding sub-optimal disposition of base mobile stations).

Thank you for attention

Questions?