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# OPTIMUM DESIGN OF UNPAVED ROADS REINFORCED WITH GEOTEXTILES: COMPARISON OF INTERNATIONALLY PUBLISHED METHODOLOGIES

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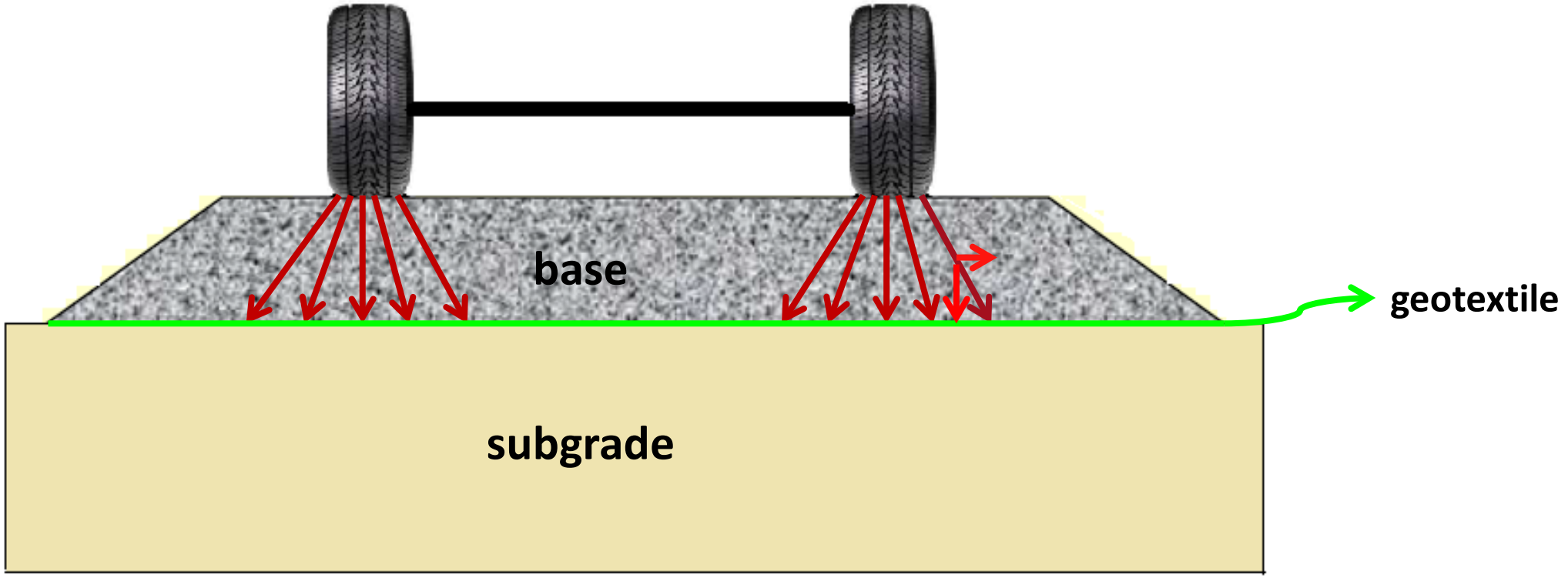
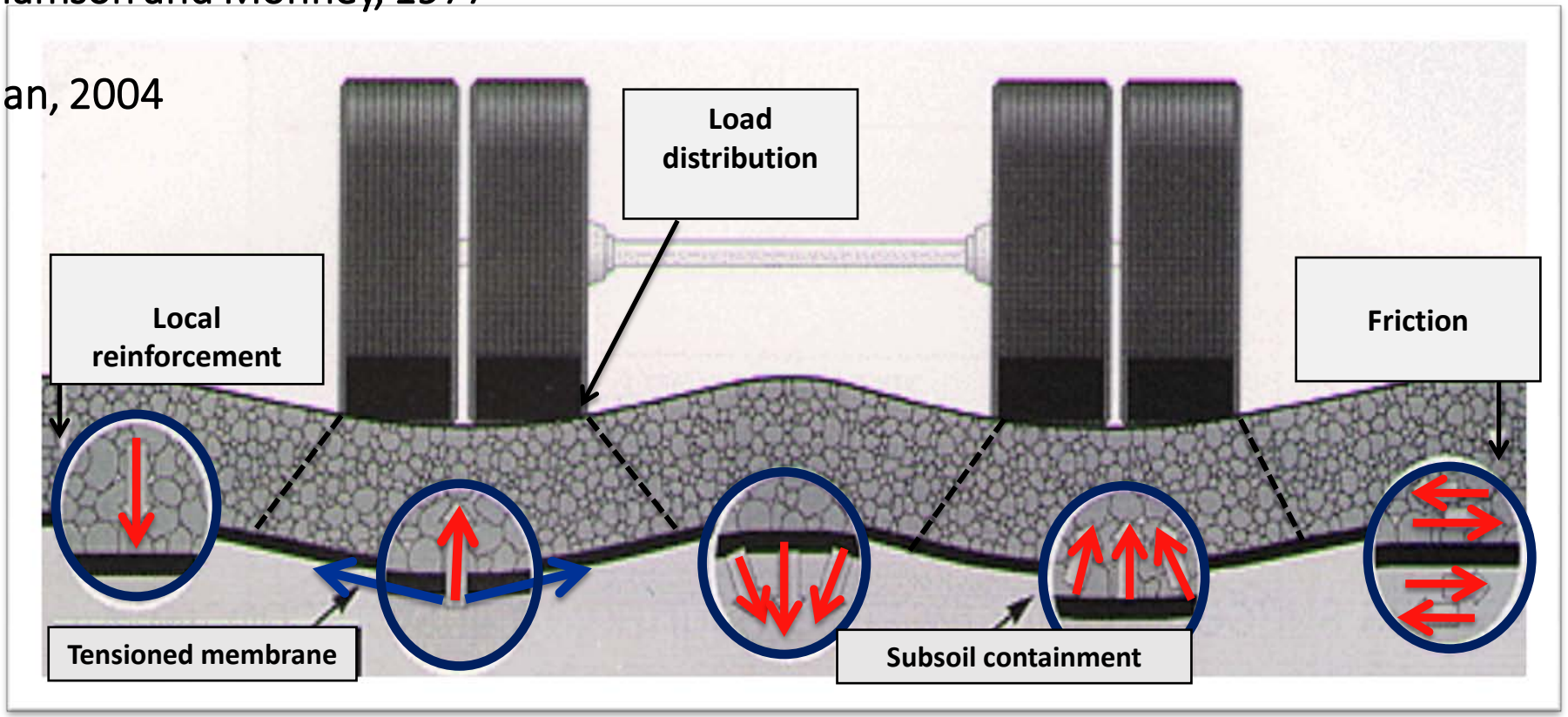
# LOAD DISTRIBUTION

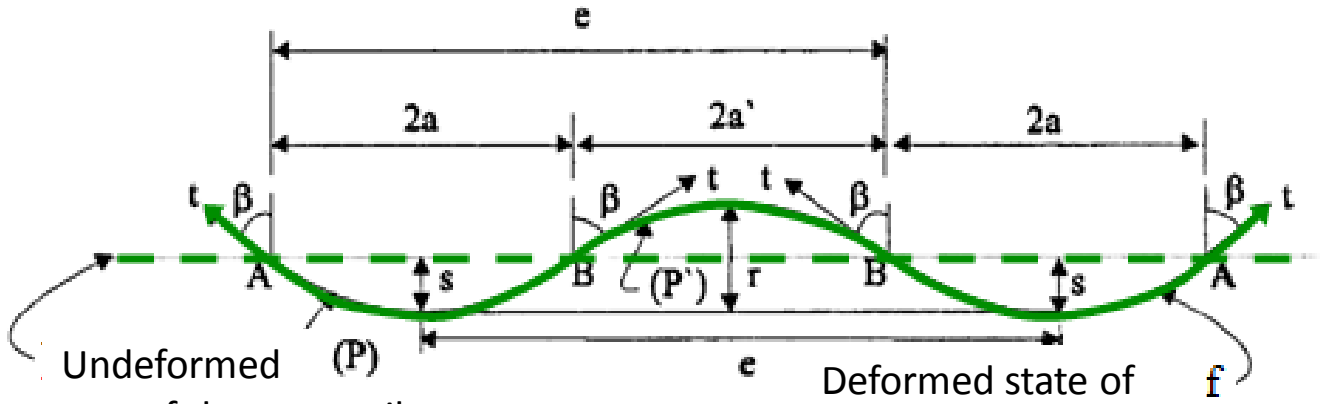


# REINFORCEMENT FUNCTION

- Giroud and Noiray 1981 and Giroud et. al, 1985
  (Holtz and Sivakugan 1987 examples considered)
- Steward, Williamson and Mohney, 1977
- Giroud and Han, 2004

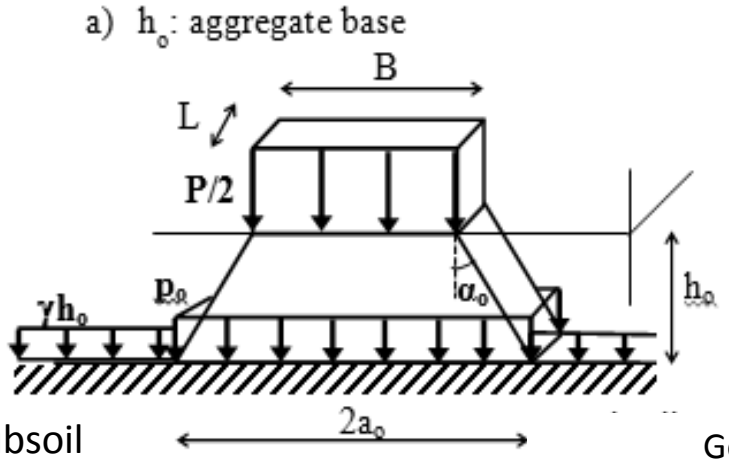


# GIROUD & NOIRAY (1981) – GIROUD et al. (1985)

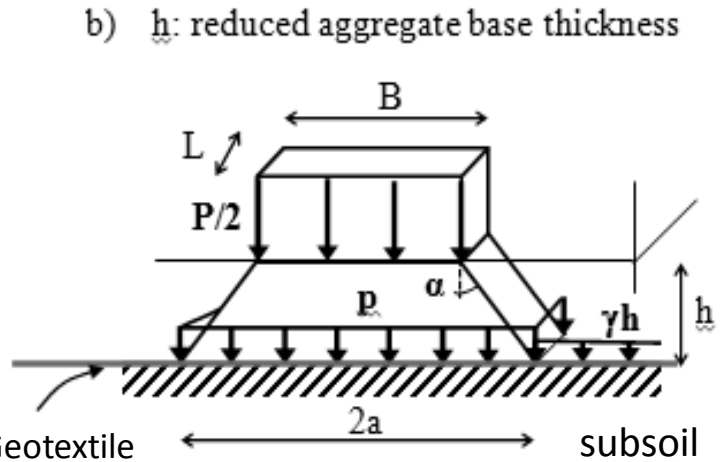



Undeformed state of the geotextile

Deformed state of the geotextile



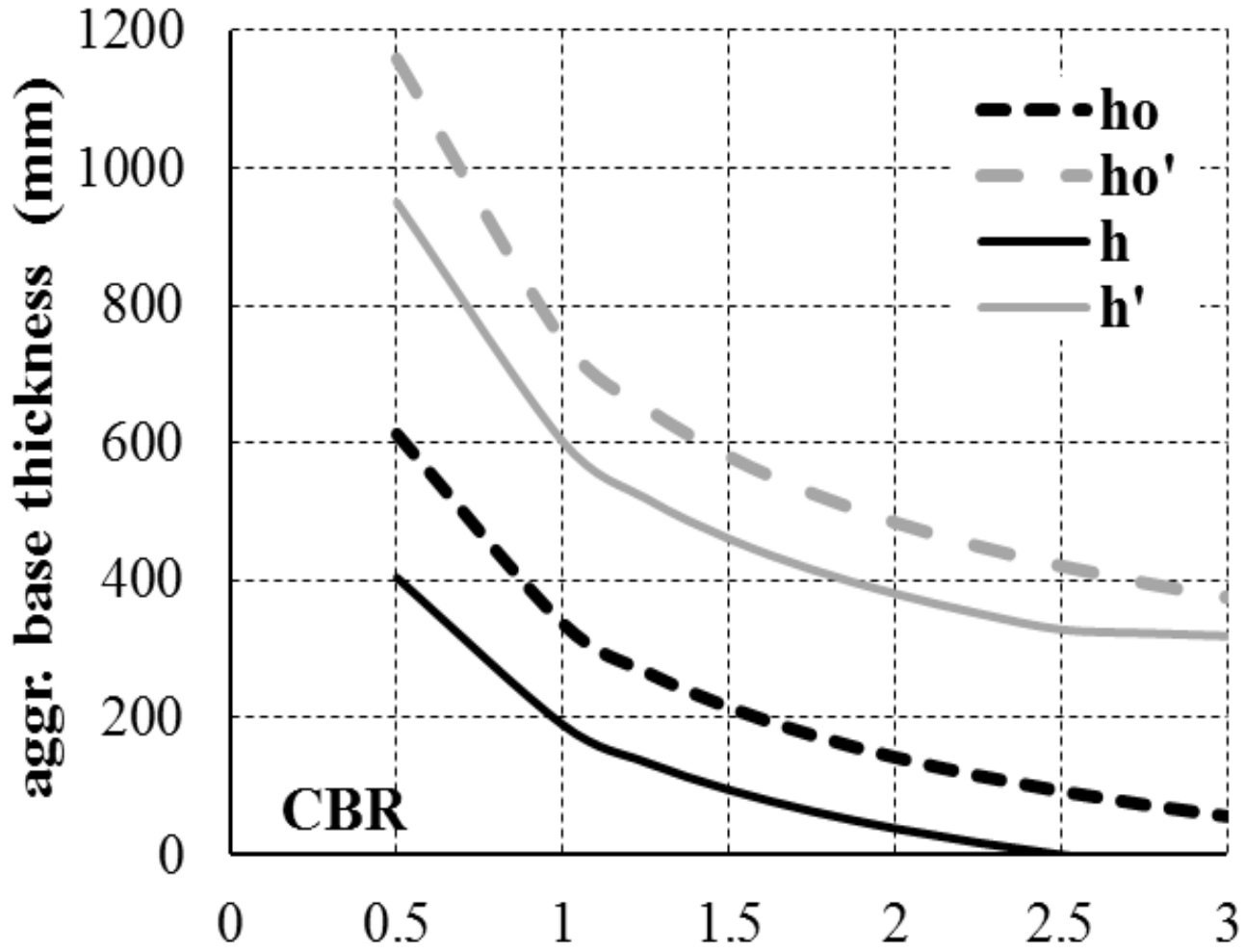

subsoil




Geotextile

subsoil

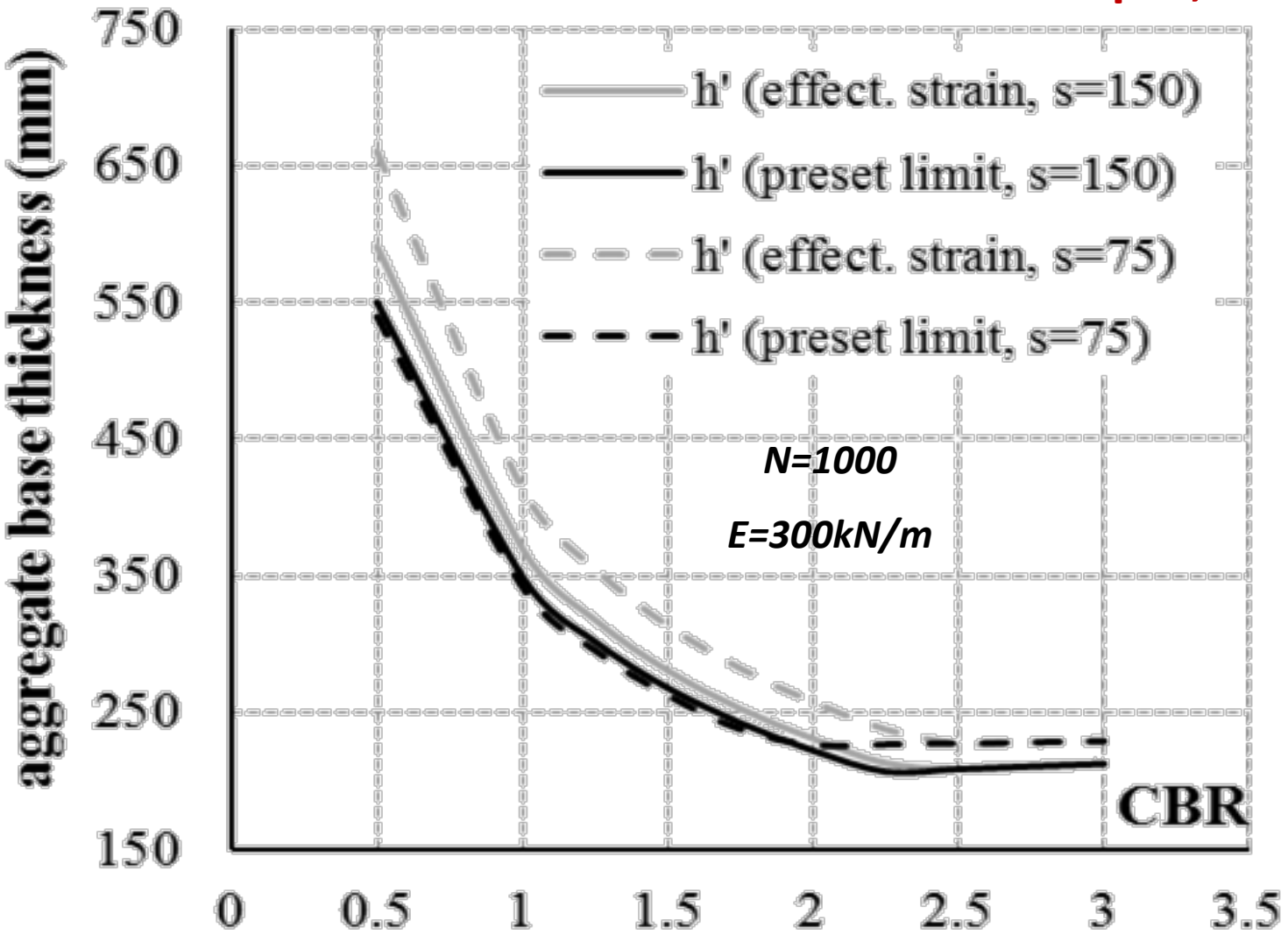
qualitative representation of the aggregate thickness –vs- CBR values of the considered unreinforced (- - -) and reinforced (——) unpaved roads



# COMPARISON OF DESIGN METHOLOGIES

| Calculation of the aggregate base thickness | Giroud and Noiray | | Holtz and Sivakugan | Giroud and Han | Steward, Williamson and Mohney |
|---|---|---|---|---|---|
| | Common parameters for all methods: CBR = 1, axle load P=80kN, Tire inflation pressure $p_c$ =480kPa, Number is passes *N=1000 (and 10.000)*, Rut depth *s=75mm*, *E=200kN/m*<br>*Note: Values in parenthesis refer to N=10.000* | | | | |
| $h_o$ (mm) | 313 (313) | | - | - | - |
| $h_o'$ (mm) | 570 (760) | | 555 (740) | 465 (510) | 475 (475) |
| h (mm) | Calculated strain: 0.013 (0.014) | 160 (160) | - | - | - |
| | Preset strain 0.1 | 113 (113) | | | |
| h' (mm) | Calculated strain: 0.013 (0.014) | 417 (607) | 432 (616) | 315 (365) | 325 (325) |
| | Preset strain 0.1 | 370 (560) | | | |

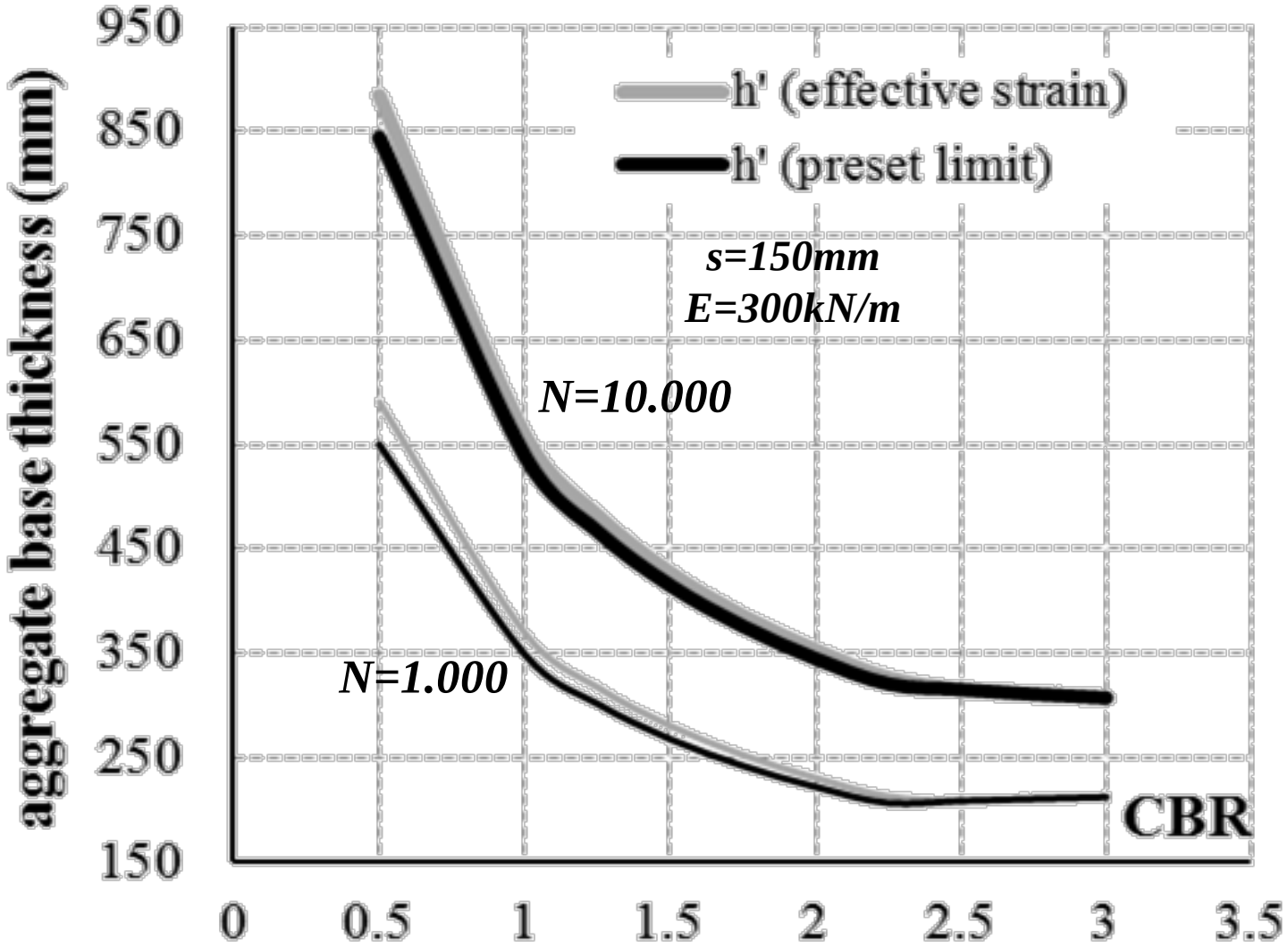
# PARAMETRIC ANALYSIS: the influence of rut depth, s




The higher *s* is, the fabric is mobilized to undertake higher effective strains in the vicinity of the preset limit resulting in very similar base thickness for a given CBR value.

- For *s*=75mm, the fabric is practically inert thus the required aggregate base thickness is maximized.

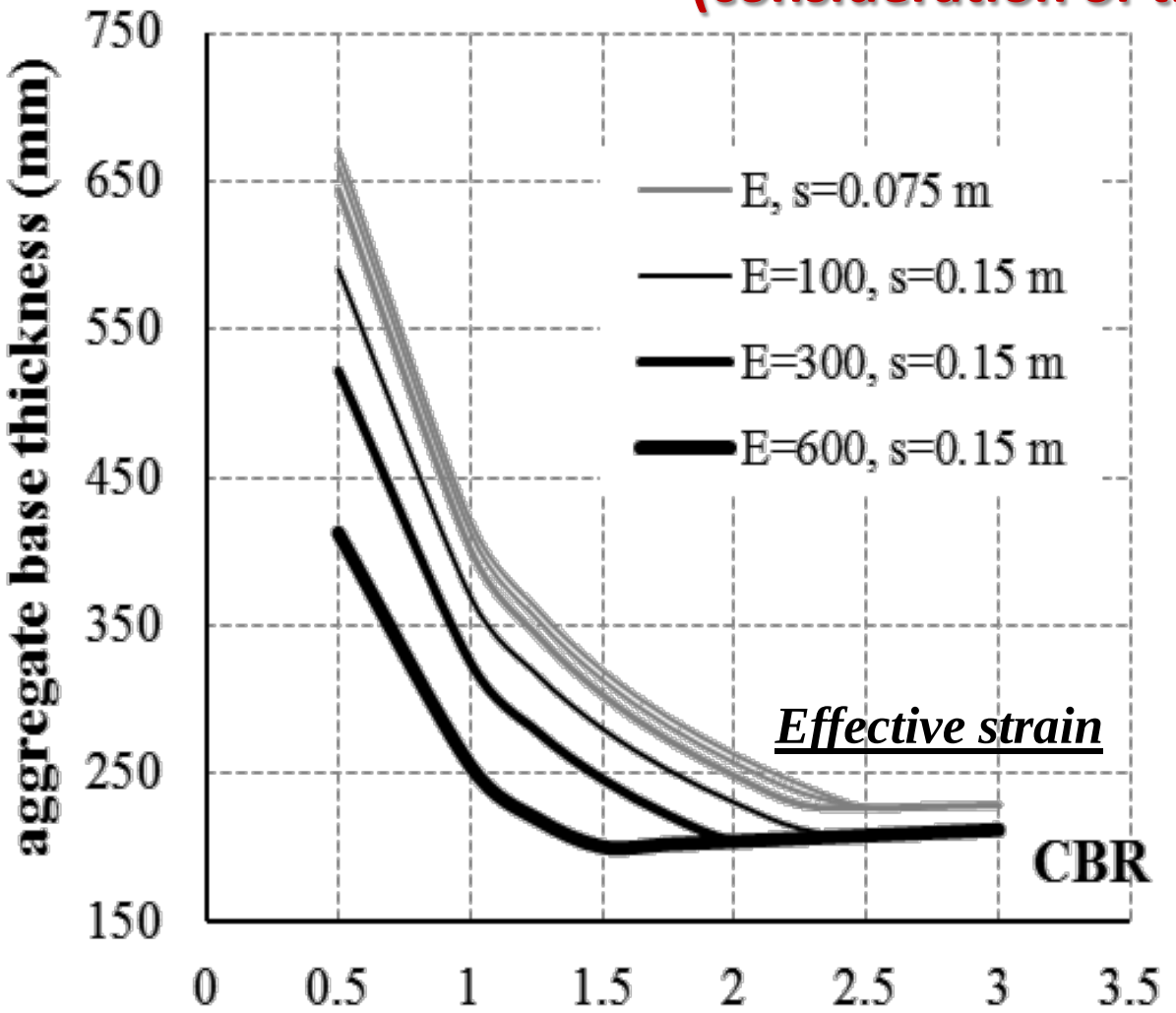
# PARAMETRIC ANALYSIS: the influence of passes number, N




The higher *N* is, a broader aggregate base is required

- For high value of *s* ➔ both strain alternatives result in similar *h'*.

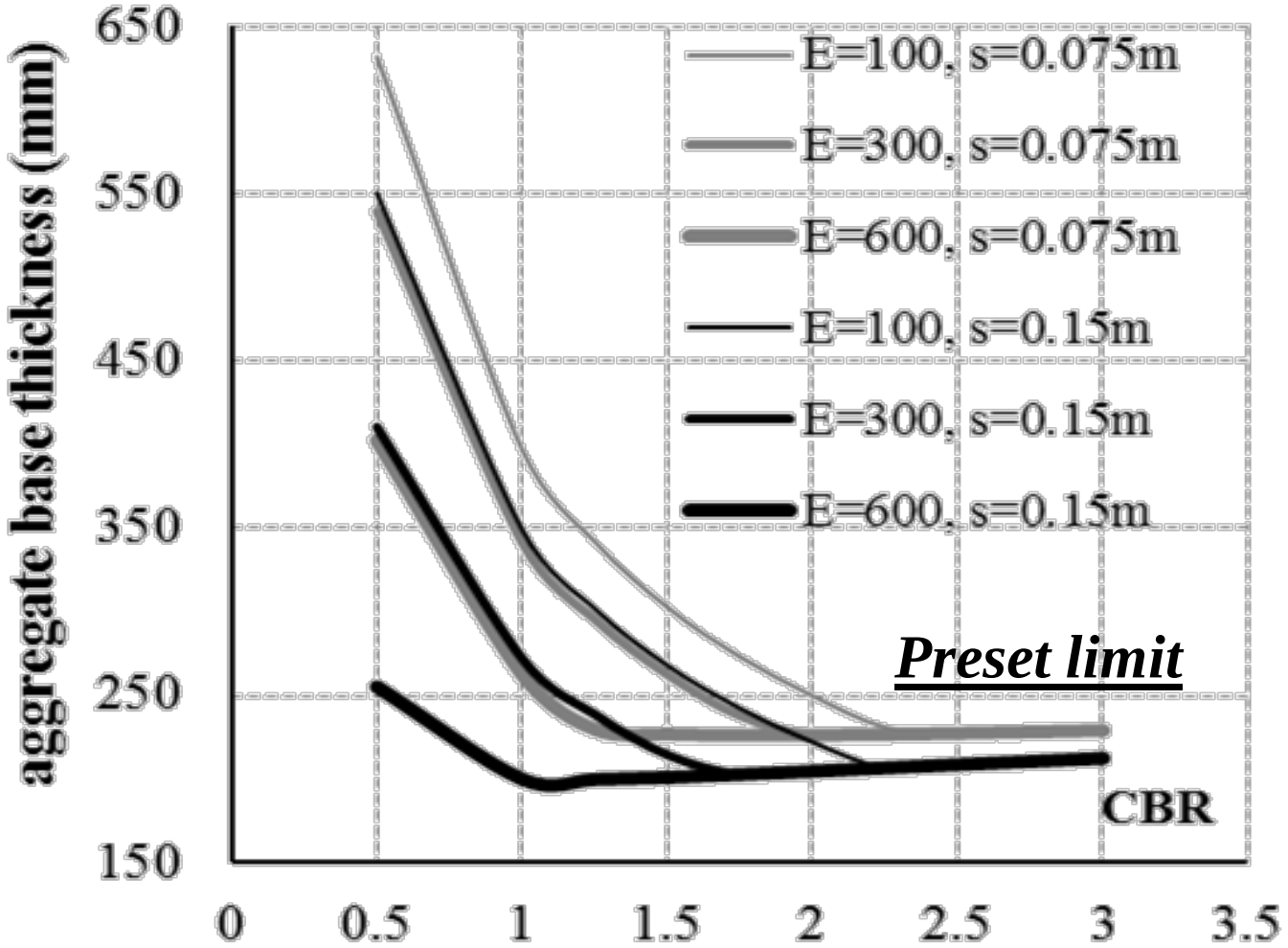
# PARAMETRIC ANALYSIS: the influence of *s* and material stiffness E (consideration of the effective strain)




Stiffer materials develop higher strains when *s* is important else the fabric is practically inert.

- grey curves: for *s*=0.075m, they aren't affected by *E* values ➔ geotextile operates mainly as separator between the layers

# PARAMETRIC ANALYSIS: the influence of *s* and material stiffness E (consideration of a preset strain limit)




Geotextiles with high *E,* allow for lower thickness *h'*. Given that the effective (**actual**) strain is usually lower than the preset value, the latter resultant h' are higher.

Note: When the designer choses a preset strain limit, the material probably will not develop it, thus the resulting *h'* will be lower than required.

➔ The actual bearing capacity is lower than assumed
➔ The performance of the reinforced unpaved road corresponds to that of a lower number of vehicle passes.
➔ This is more critical when *s* is minimum and *E* is high.

## CONCLUSIONS

- Internationally accepted methodologies for design of reinforced unpaved roads were collected and critically assessed
- Method of Giroud and Noiray (1981) and Giroud et al. (1985), was considered for parametric analyses
- Spreadsheets were developed with embedded subroutines
- Parametric studies were conducted considering the main design parameters
- The importance of the geotextile strain (preset limit vs effective strain) on the required aggregate base thickness was highlighted

# OPTIMUM DESIGN OF UNPAVED ROADS | COMPARISON OF INTERNATIONALLY PUBLISHED METHODOLOGIES

Thank you for your attention

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A WORLD OF MATERIALS & SOLUTIONS