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Impact of Median Jersey Barriers in the Design of Compound Alignments

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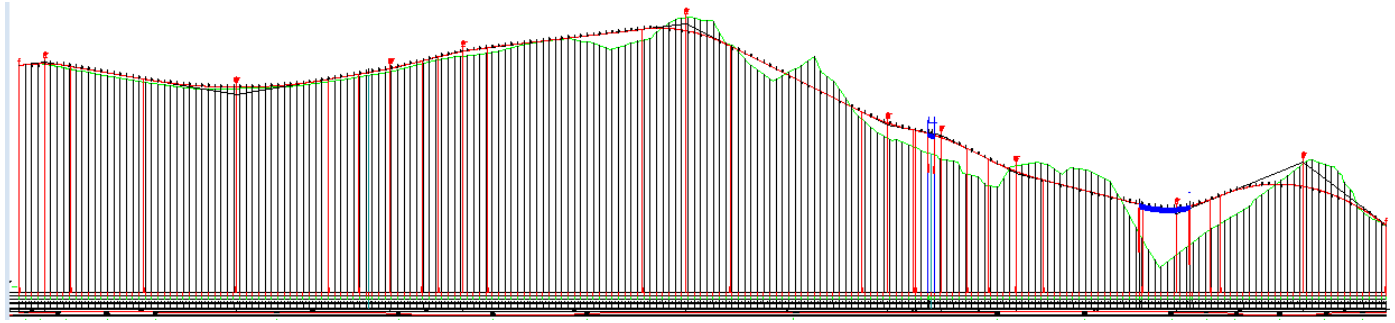
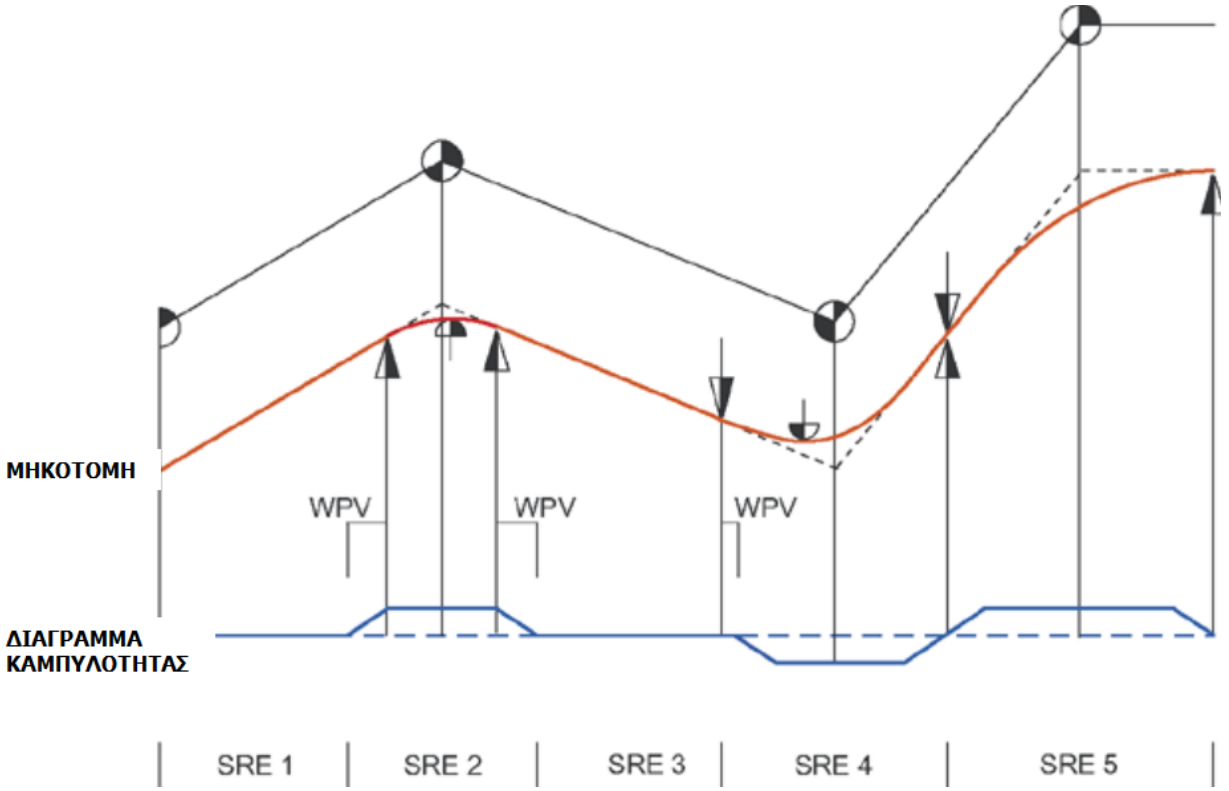
3D Highway Geometry

- 2 Independent and mostly uncorrelated 2D stages
  - horizontal alignment
  - vertical alignment
- 2D approach associated with design misconceptions affecting design performance adversely
  - typical case: SSD



Current Practice

- 2D Approach
  - efforts to overcome this incorrect SSD determination
    - coordination between horizontal and vertical curve positioning
  - not all design cases are addressed



Left Curved Divided Highways

- Median barriers
  - increase level of safety
- Necessity for SSD adequacy
- No Explicit Process Provided
  - no assurance whether barrier height and/or vertical curve do not obstruct driver's line of sight

Left Curved Divided Highways – SSD Adequacy Breakpoint

$SSD_{DEMANDED} \leq SSD_{AVAILABLE}$

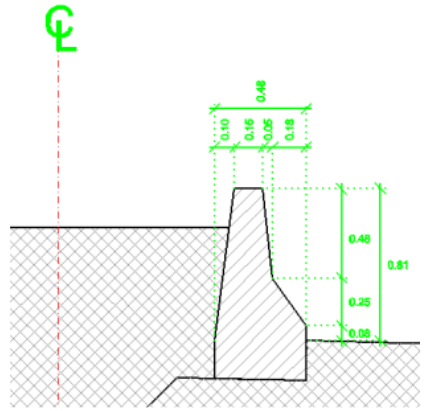
- Options
  - determine the examined curve's inferred safe speed
  - define the inner shoulder width for a desired speed

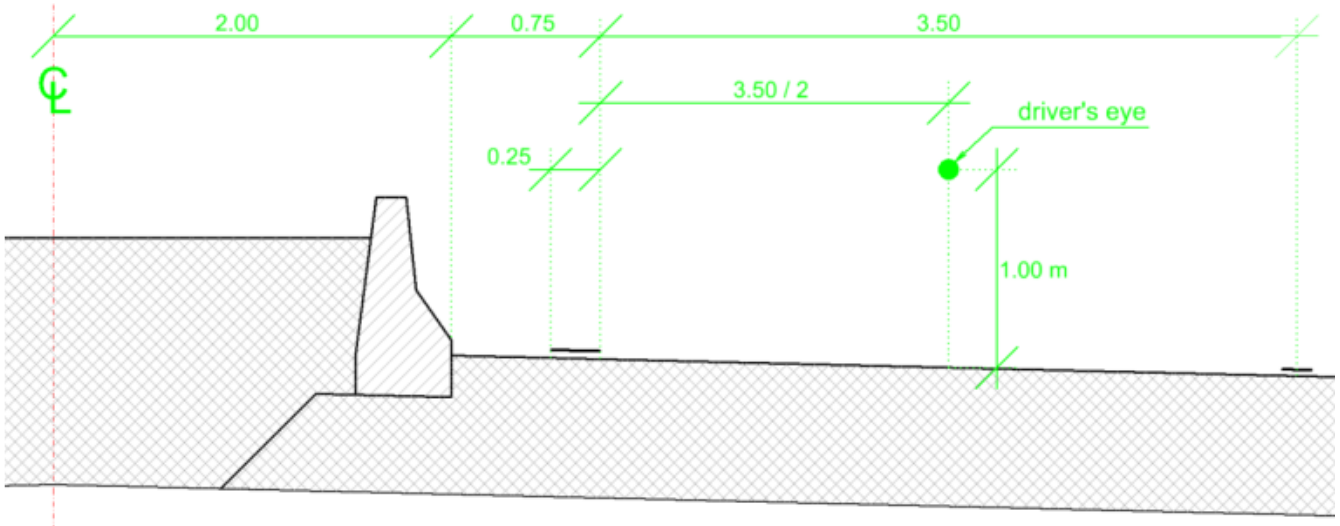
Objectives

- Deliver **analytical tool** for SSD assessments
- **Quantify safety impact**
  of median Jersey barriers
  during emergency braking conditions
  on compound alignments
  - left horizontal curves (R)
  - crest vertical curves (H_k)
- **Identify** areas of **interrupted vision lines**
  between driver and object
- Examine **interaction**
  of utilized **design parameters**

SSD Assessment (1/2)

- RAA 2008 Design Guidelines
  - V =130km/h
  - $t_{perception\text{-}reaction}$ = 2.0sec, a=3.7m/sec^2
  - $h_{driver's\ eye} = h_{object}$ = 1.00m
  - crest vertical curve grade boundary values: s = ±4.0%
- Passing lane width = 3.50m
- Inner shoulder width = 0.75m
- NJ median barrier (0.90m high)
- Variety of horizontal – vertical parameters

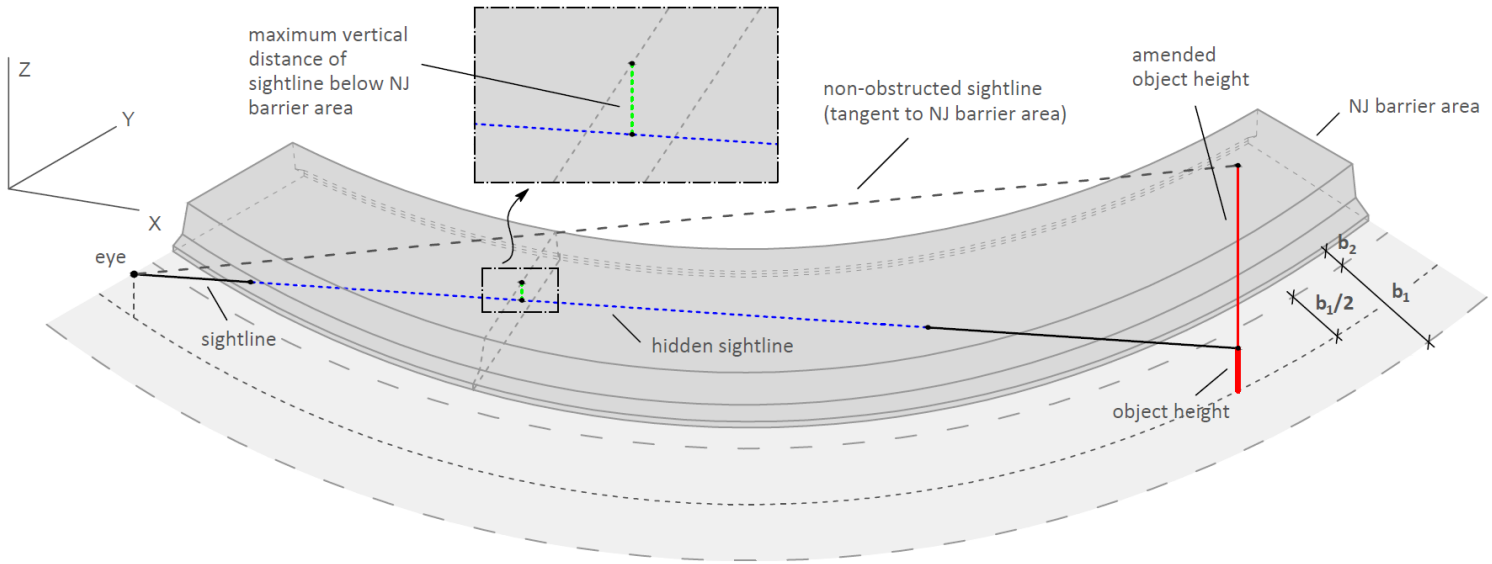




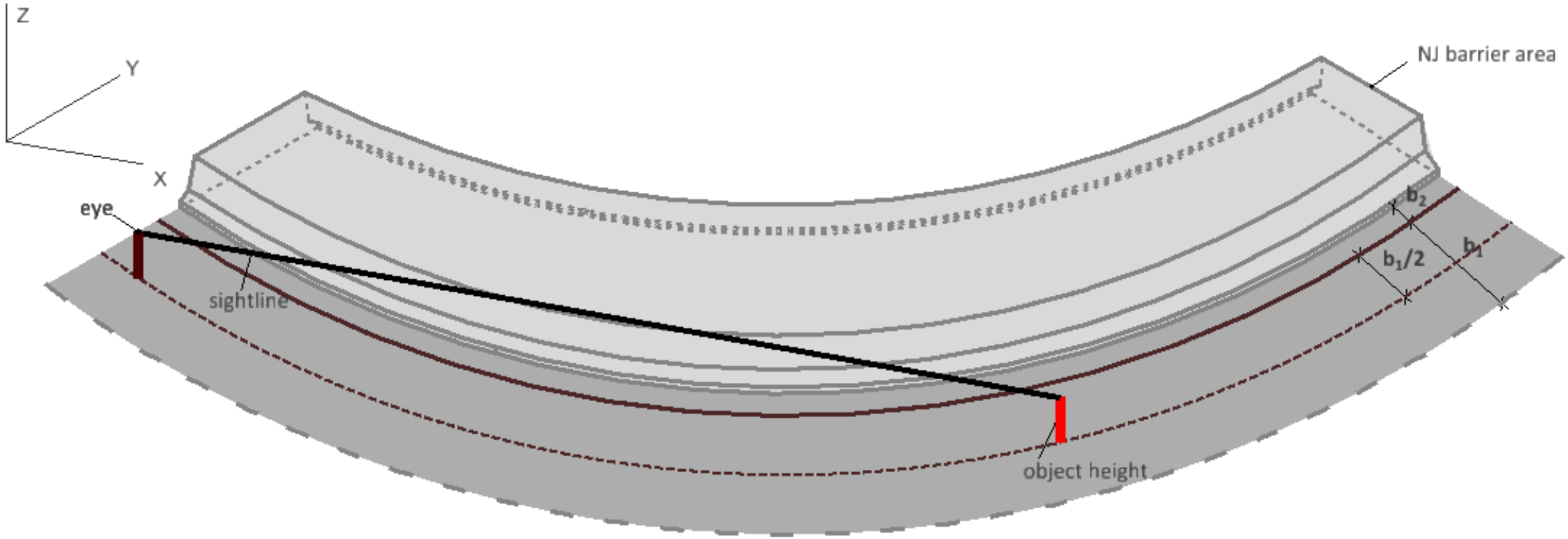
SSD Assessment (2/2)

$SSD_{DEMANDED} \leq SSD_{AVAILABLE}$

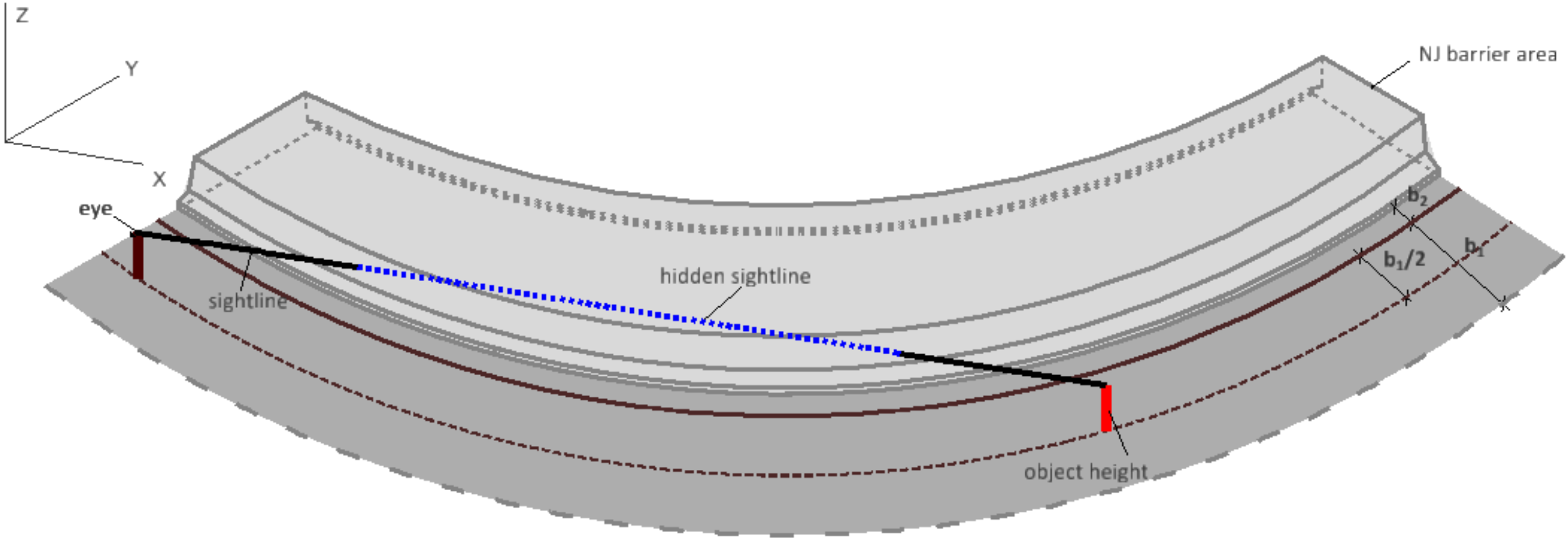
- 3D $SSD_{DEMANDED}$
  - enriched point mass model
    - actual values of grade (vertical curves)
    - friction variation (vehicle cornering)
- 3D $SSD_{AVAILABLE}$
  - driver's line of sight towards object height



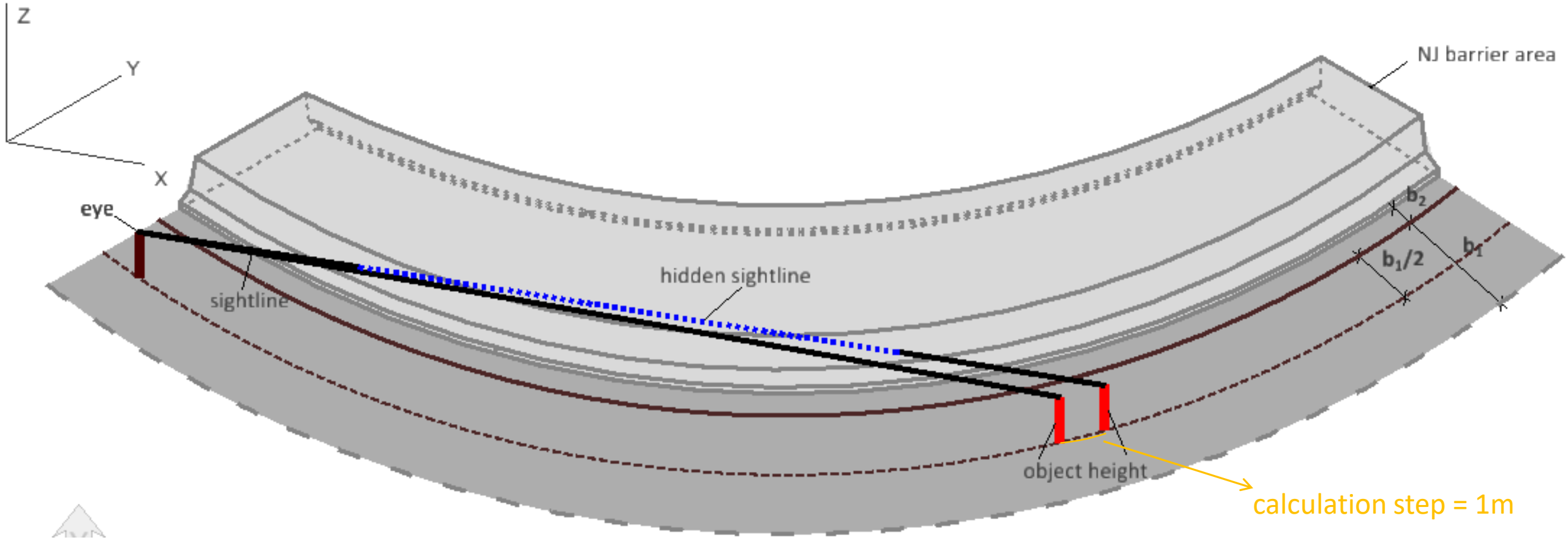
$SSD_{AVAILABLE}$ (Station A)



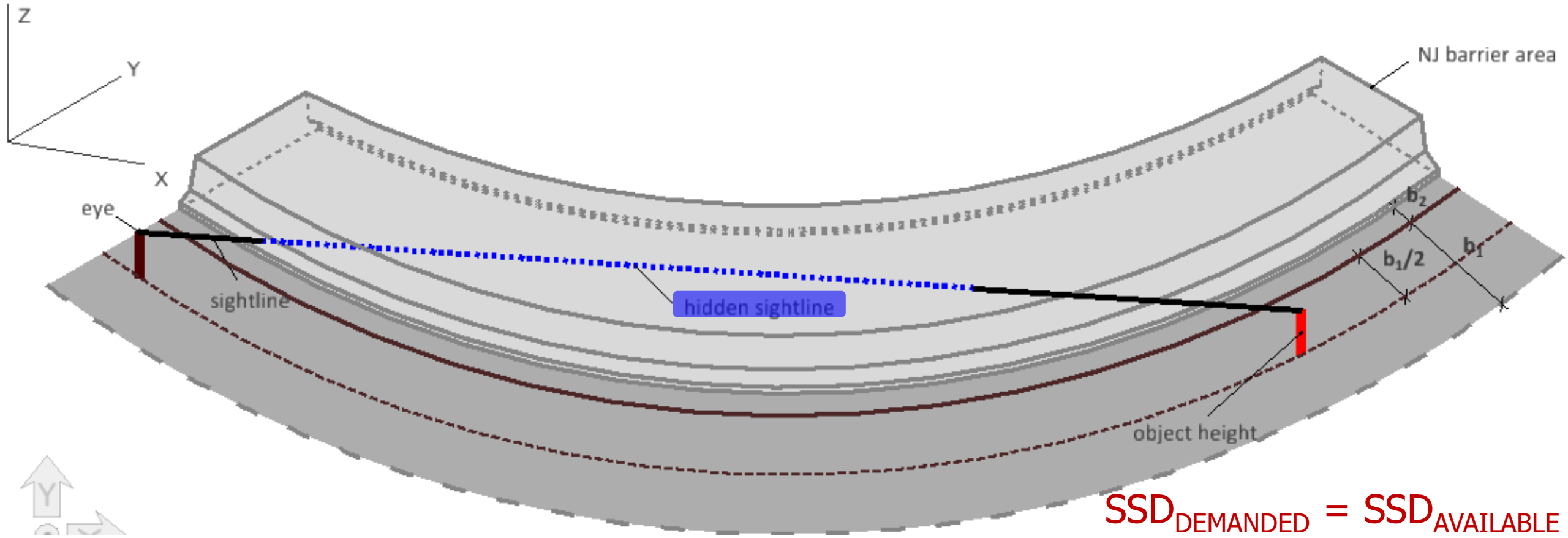
$SSD_{AVAILABLE}$ (Station A + calc. step)



$SSD_{AVAILABLE}$ (Station A) vs $SSD_{AVAILABLE}$ (Station A + calc. step)



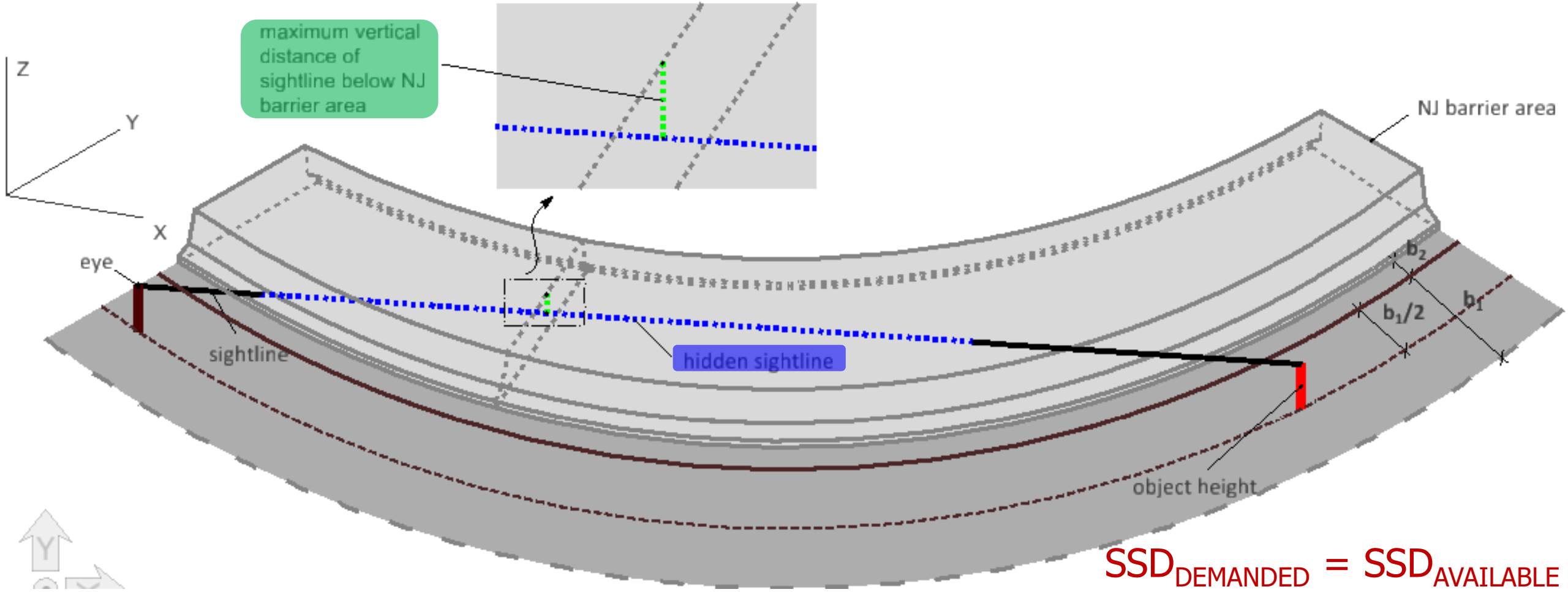
SSD Modeling Proposal (1/3)



$SSD_{DEMANDED} = SSD_{AVAILABLE}$

SSD Modeling Proposal

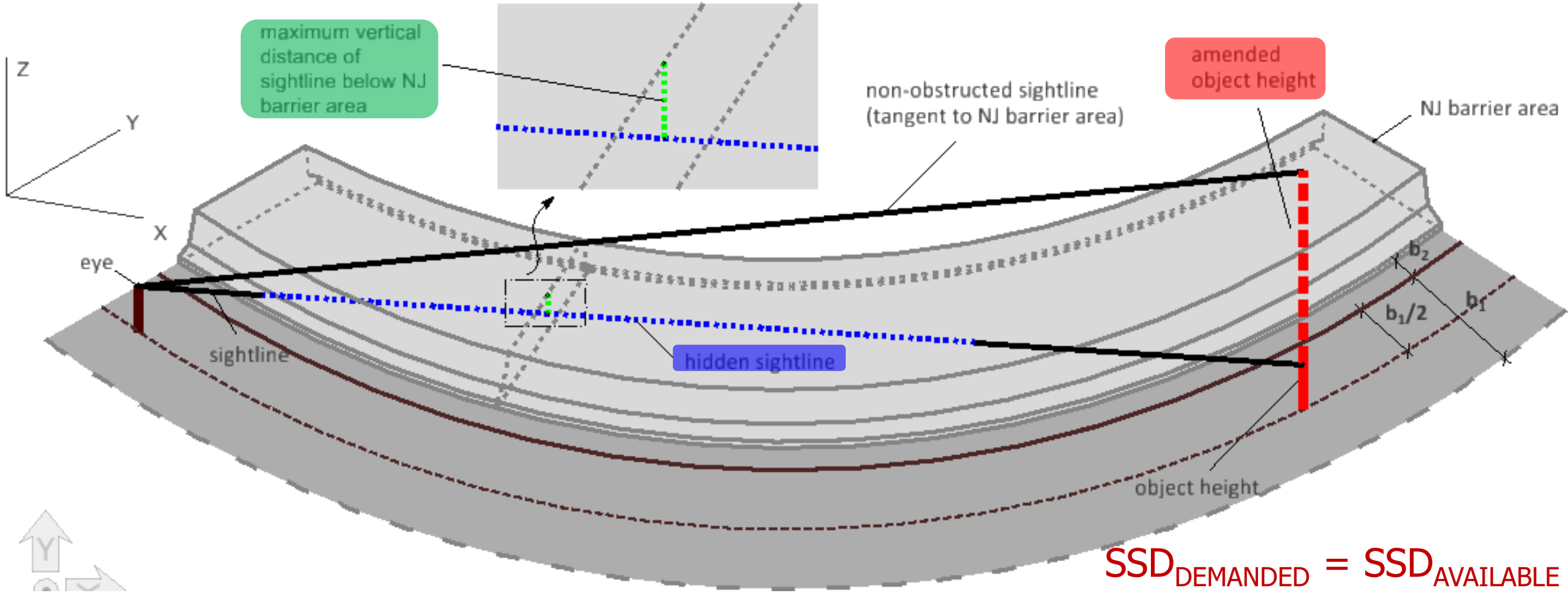
(2/3)



$SSD_{DEMANDED} = SSD_{AVAILABLE}$

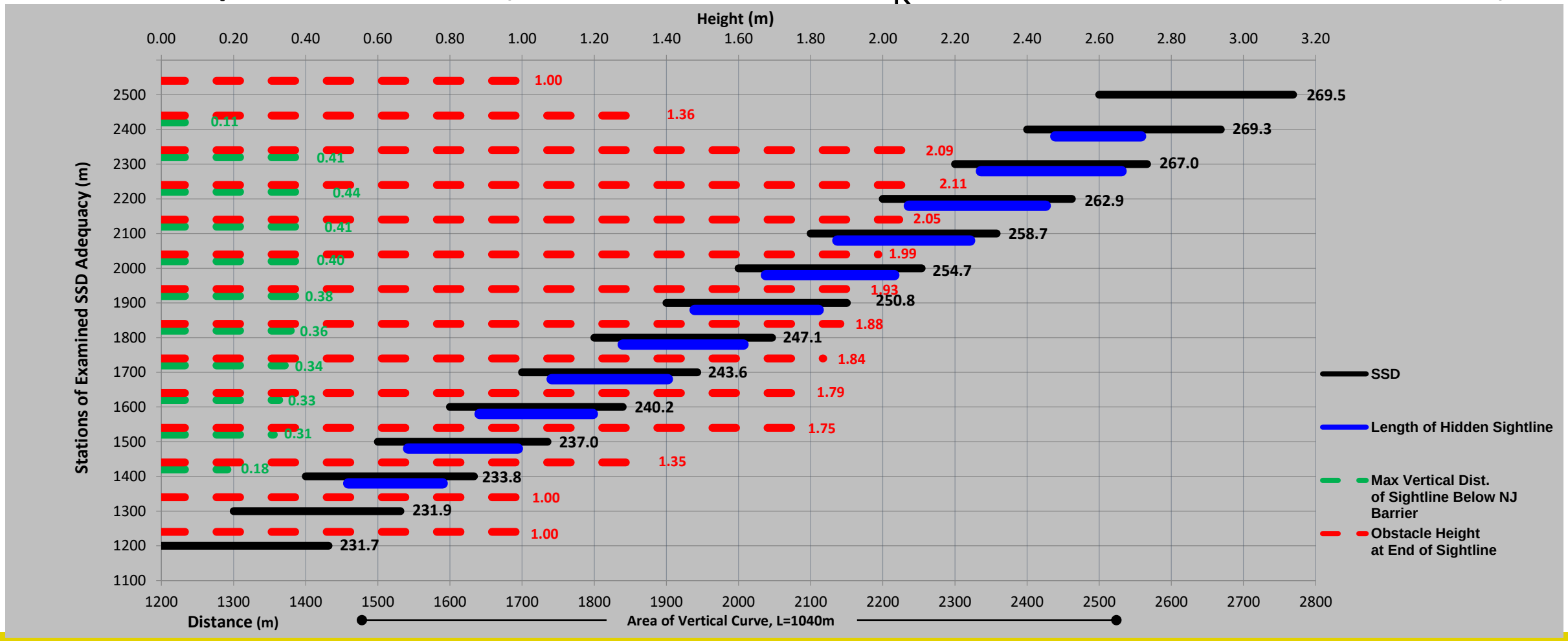
SSD Modeling Proposal

(3/3)



$SSD_{DEMANDED} = SSD_{AVAILABLE}$

Output Data (R=1500m, H_k=13000m, s=±4.0%)



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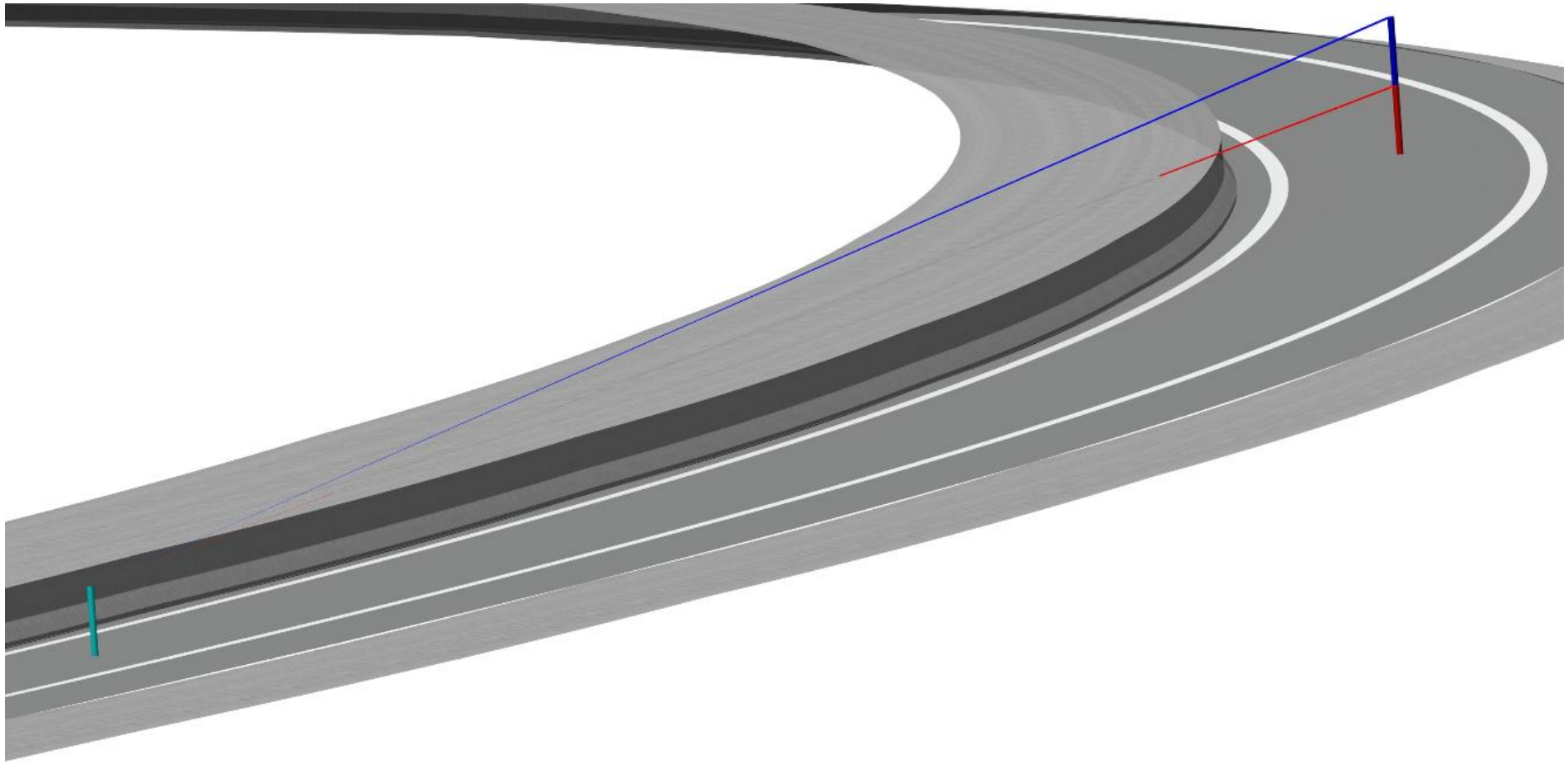

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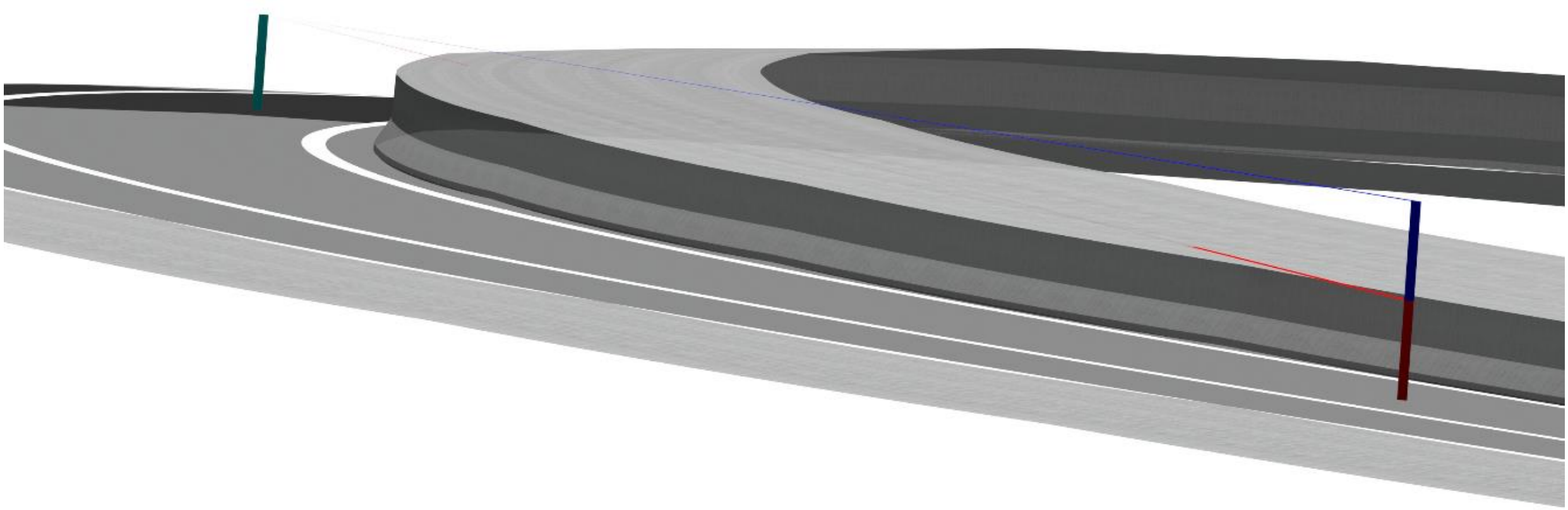

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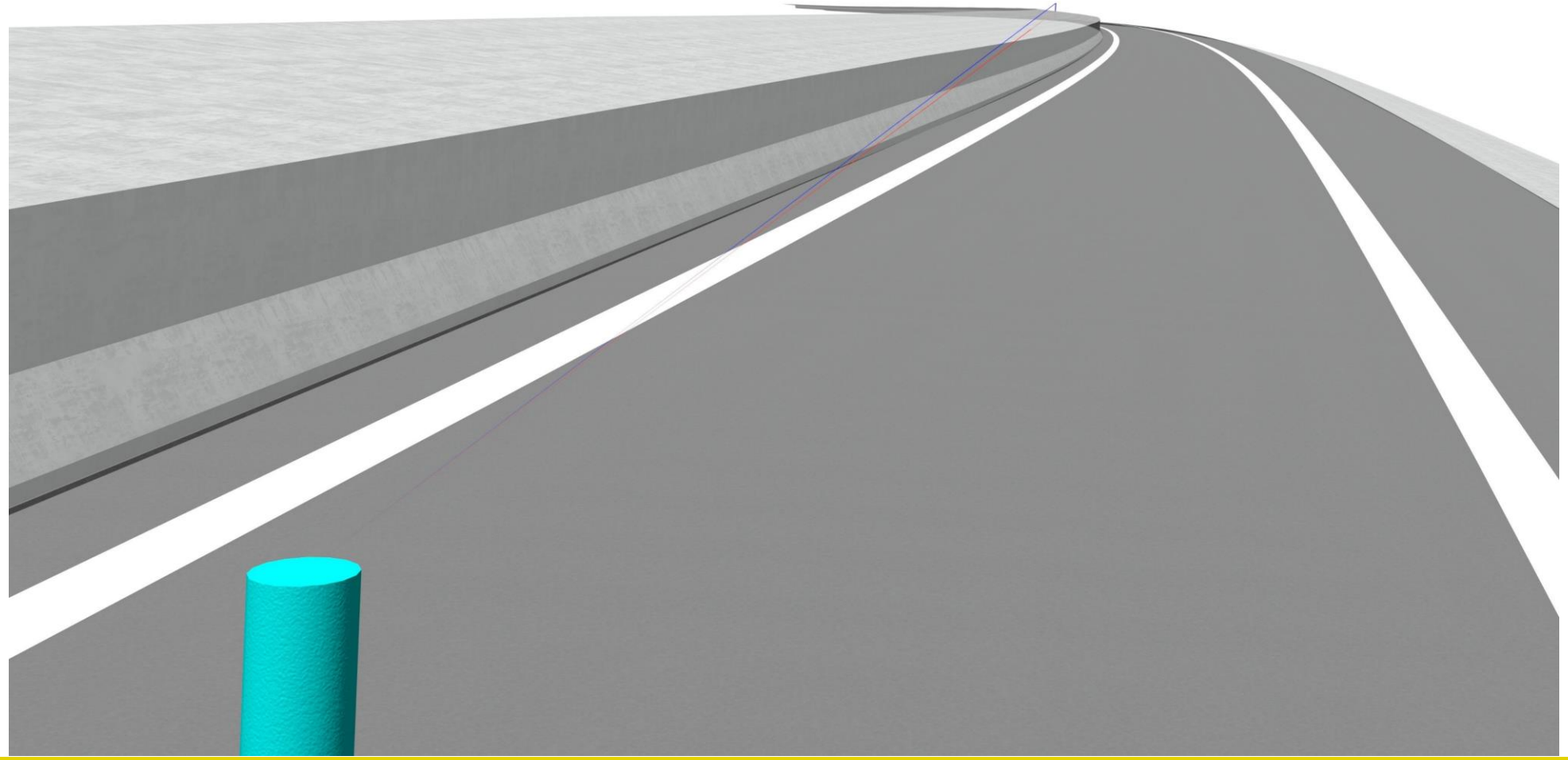


24 Examined Alignments

- $SSD_{DEMANDED}$ reduction (%)
  - h_{object} = 1.00m

	CVCR (m)				
		13000	20000	25000	40000
R (m)	900	>39%	>25%	>16%	0%
	1500	>32%	>25%	>16%	0%
	2000	>22%	>22%	>16%	0%
	2500	>12%	>12%	>12%	0%
	3000	4%	4%	4%	0%
	3500	0%	0%	0%	0%

Can We Reduce $SSD_{DEMANDED}$?

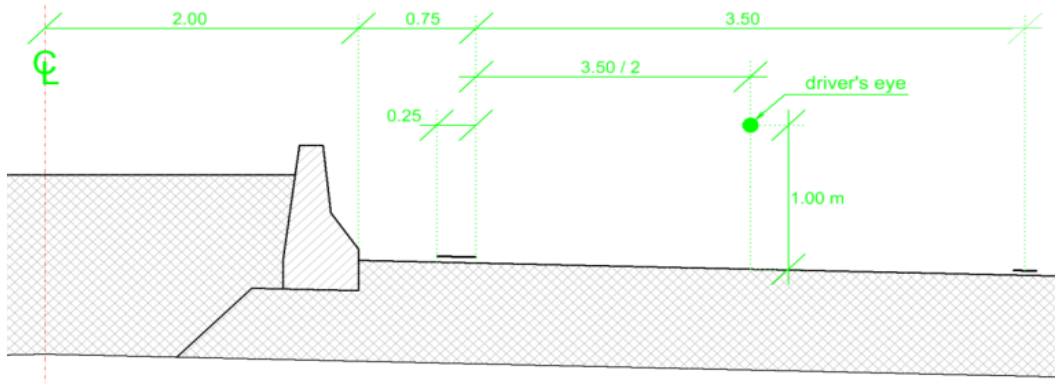
- Introduction of:

"tolerable road length not visible to the driver"

  - $SSD_{AVAILABLE}$ = $SSD_{DEMANDED}$ reduced by 9%-12%
    - deceleration rate 3.7m/sec^2 → 4.3m/sec^2

Acceptable Arrangements of Compound Alignments

- SSD Adequacy
  - V=130km/h
  - s=±4.0%
  - a=4.3m/sec^2
  - $h_{driver's\ eye} = h_{object} = 1.00m$



Note: ✓ acceptable arrangements, ✓* acceptable arrangements for exit grades not bellow s= -2.5%, × unacceptable arrangements

R (m) \ CVCR (m)	13000	20000	25000	40000
900	×	×	✓*	✓
1500	×	×	✓*	✓
2000	×	×	✓*	✓
2500	✓	✓	✓	✓
3000	✓	✓	✓	✓
3500	✓	✓	✓	✓

Conclusions

- 24 compound alignments examined (V=130km/h)
- Extensive SSD shortage areas defined
- Introduction of:
  “tolerable road length not visible to the driver”
- Additional work
  - examine more speed values
  - optimize effect of additional parameters involved
    - inner shoulder width
    - median barrier type for certain cases
      (e.g. bridge – tunnels, etc.)
  - night time driving
  - issues associated to human factors

Thank You

Additional Information:

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