MODEL FOR SIGHT DISTANCE CALCULATION AND THREE-DIMENSIONAL ALIGNMENT EVALUATION IN DIVIDED AND UNDIVIDED HIGHWAYS

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Presentation Overview

- Background
- Objective
- H11 System
- Methodology
- Applications
- Conclusions

Background

- Driving safety and highway esthetics
  - Design consistency
  - Mental workload
  - Visual cues
  - Coordination of horizontal and vertical alignment
  - Human factors

Background

- Tool for spatial road alignment evaluation:
  - ✓ **Perspective images from the driver's eye position!**
- Current design practices
- Contemporary road design softwares

Objective

- Perspective views generation from all the driver's successive viewpoints along the roadway
- Integration of the calculable concept of **sight distance**

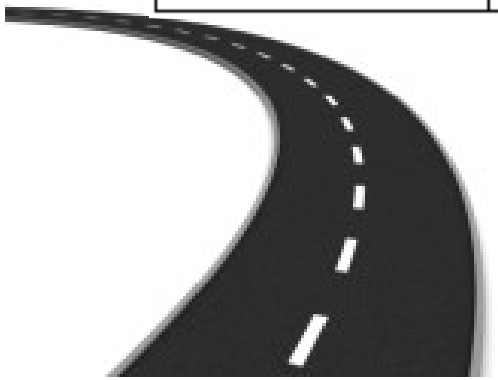
H11 System

- NTUA
- All tasks related to highway geometric design
- Respective drawings
  - AASHTO 2004
  - RAA 2008
  - Austroads 2009
  - OMOE 2001

H11 System

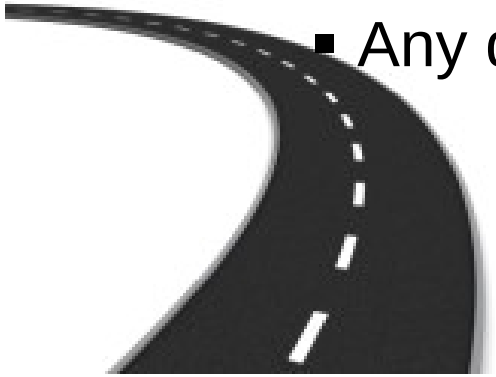
- ✓ Operating speed diagram
  - V_{85}
  - Calculation for every single geometric element
  - Greek guidelines
  - Design consistency evaluation

¤	**Design evaluation¤**		
Safety Criterion¤	**Good¤**	**Fair¤**	**Poor¤**
I¤	$\|V_{85i}-V_{ei}\| \leq 10$km/h¤	10km/h < $\|V_{85i}-V_{ei}\| \leq 20$km/h¤	$\|V_{85i}-V_{ei}\| > 20$km/h¤
II¤	$\|V_{85i}-V_{85i+1}\| \leq 10$km/h¤	10 km/h < $\|V_{85i}-V_{85i+1}\| \leq 20$km/h¤	$\|V_{85i}-V_{85i+1}\| > 20$km/h¤

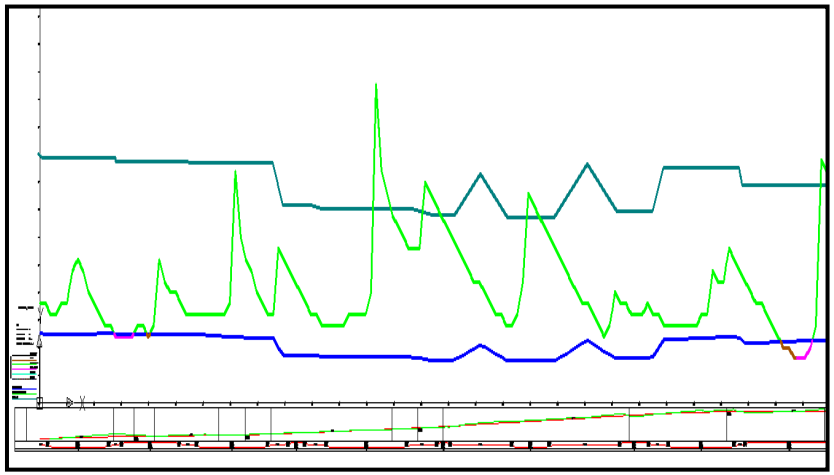


H11 System

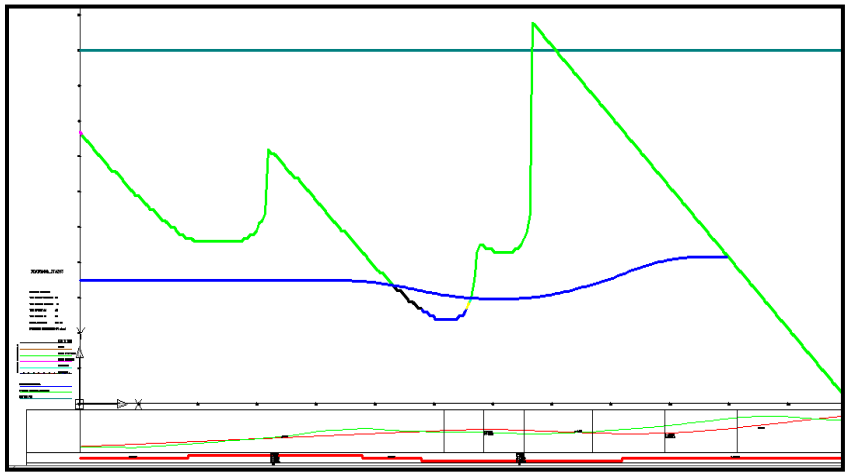
- ✓ Visibility diagram
  - 3D model of the road and its environment (cuts, central medians, barriers)
  - SSD: equations from current guidelines
  - ASSD: intersection of driver's line of vision with the first triangle that restricts his visibility
  - PSD: standard values from current guidelines
  - APSD: similarly to ASSD **(only** undivided highways)
  - Any desired interval, both directions



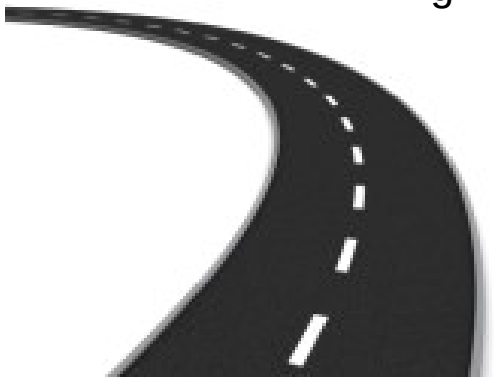
H11 System



ASSD diagram for an undivided highway



ASSD diagram for a divided highway

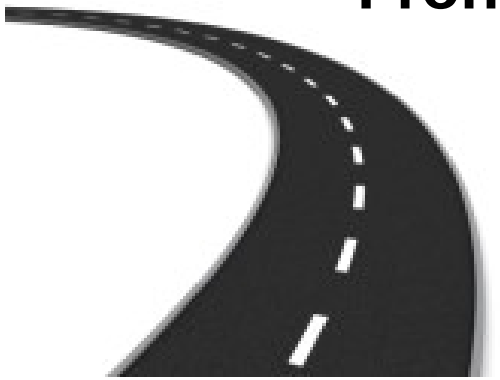


H11 System

✓ Perspective images

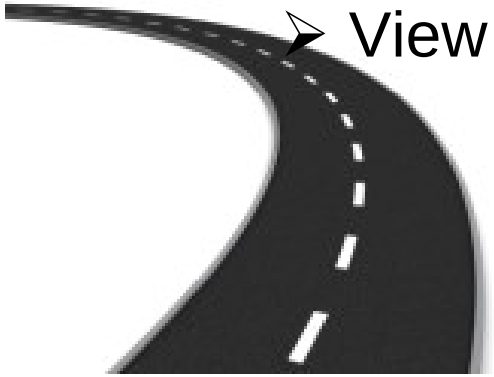
➢Depiction of:

- Road surface
- Roadside natural and possible artificial features
- Central medians
- **Back image of a vehicle at the SSD**
- **Front image of a vehicle at the PSD**



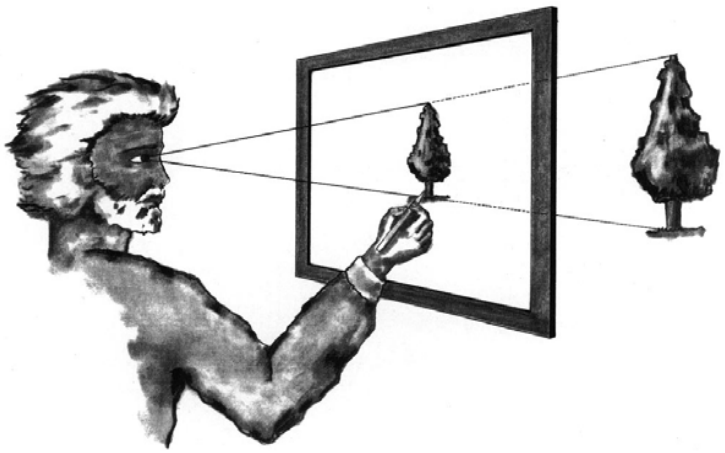
H11 System

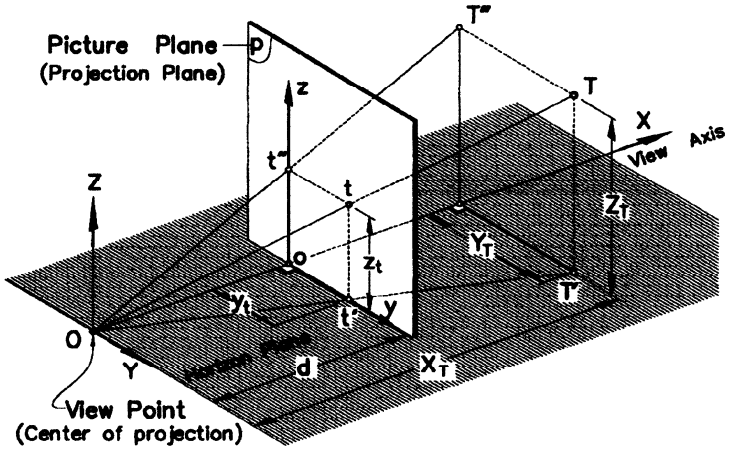
- ✓ Perspective images
  - ➢ Any desired step
  - ➢ Both directions
  - ➢ Roadlines
  - ➢ Visibility angle
  - ➢ Successive images one above the other
    - ✓ Direct supervision of the whole length of the project
    - ✓ Feeling of movement
  - ➢ Perspective from any spot of the 3D space around the driver's station
  - ➢ View axis: tangent to driver's roadline



Methodology

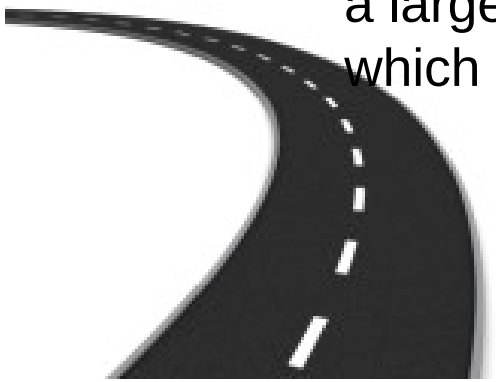
- Principles of Perspective Geometry





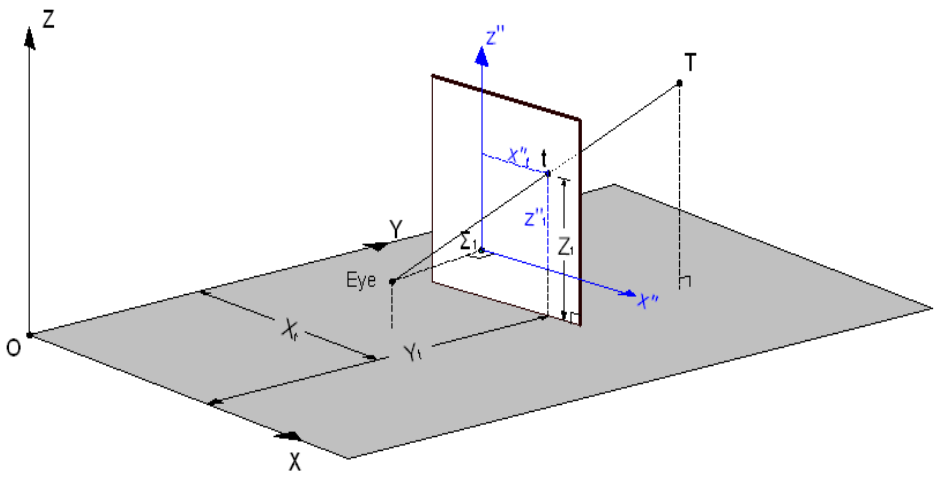
(Source: Taiganidis & Kanellaidis, 1999)

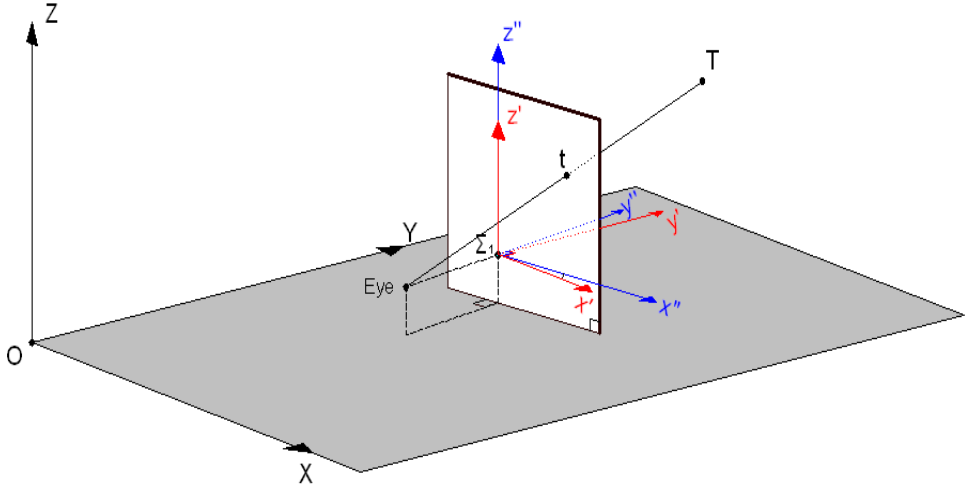
- Central projection at a perpendicular plane in front of the driver of a large number of points with known spatial coordinates X, Y, Z, which approximately form the spatial layout of the project



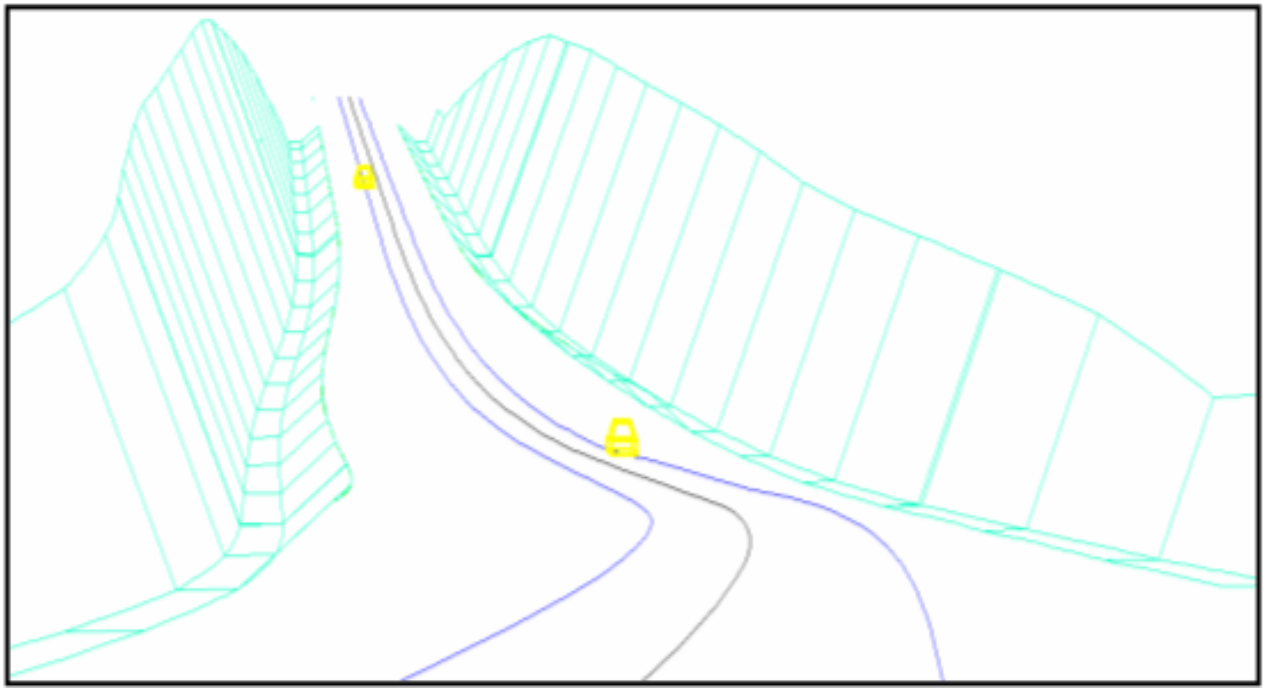
Methodology

- Use of analytical friction models for:
  - the expression of the projection plane
  - the expression of the line of vision at 3D space
  - the definition of the intersection point of the line of vision and the projection plane
  - the transformation of the 3D coordinates of the intersection points into the corresponding 2D coordinates of the projection plane



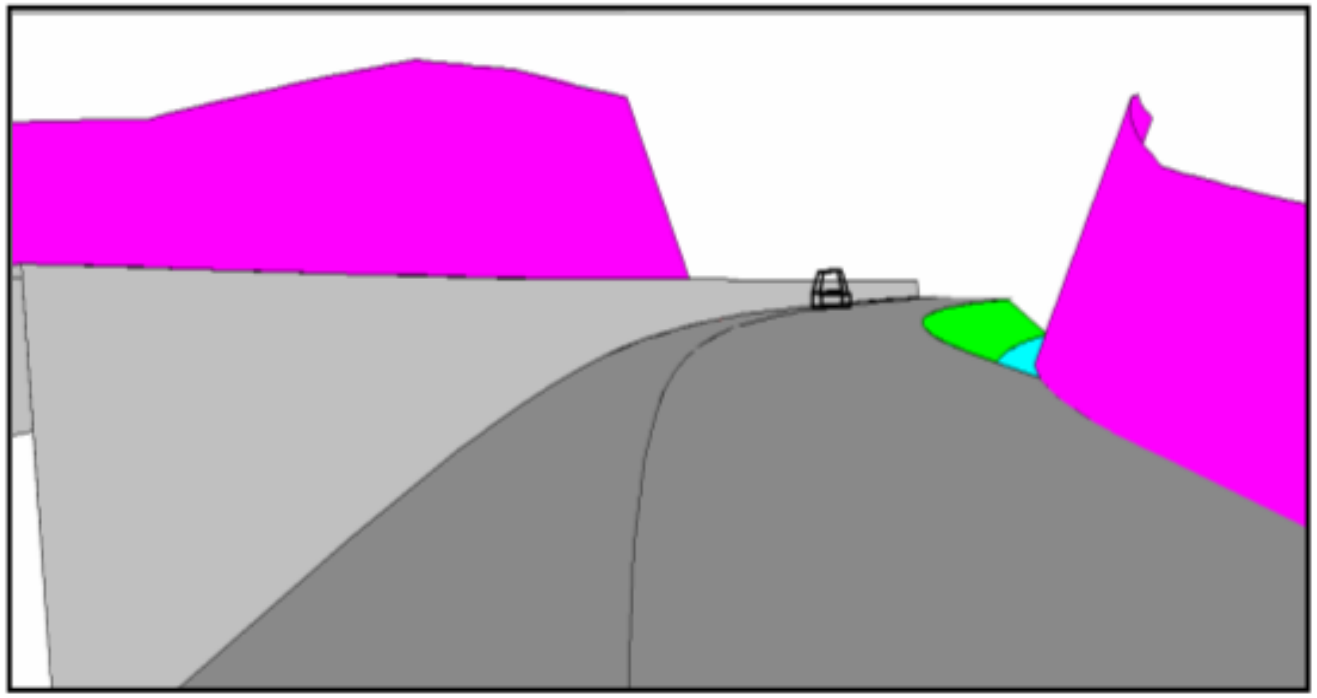


Applications



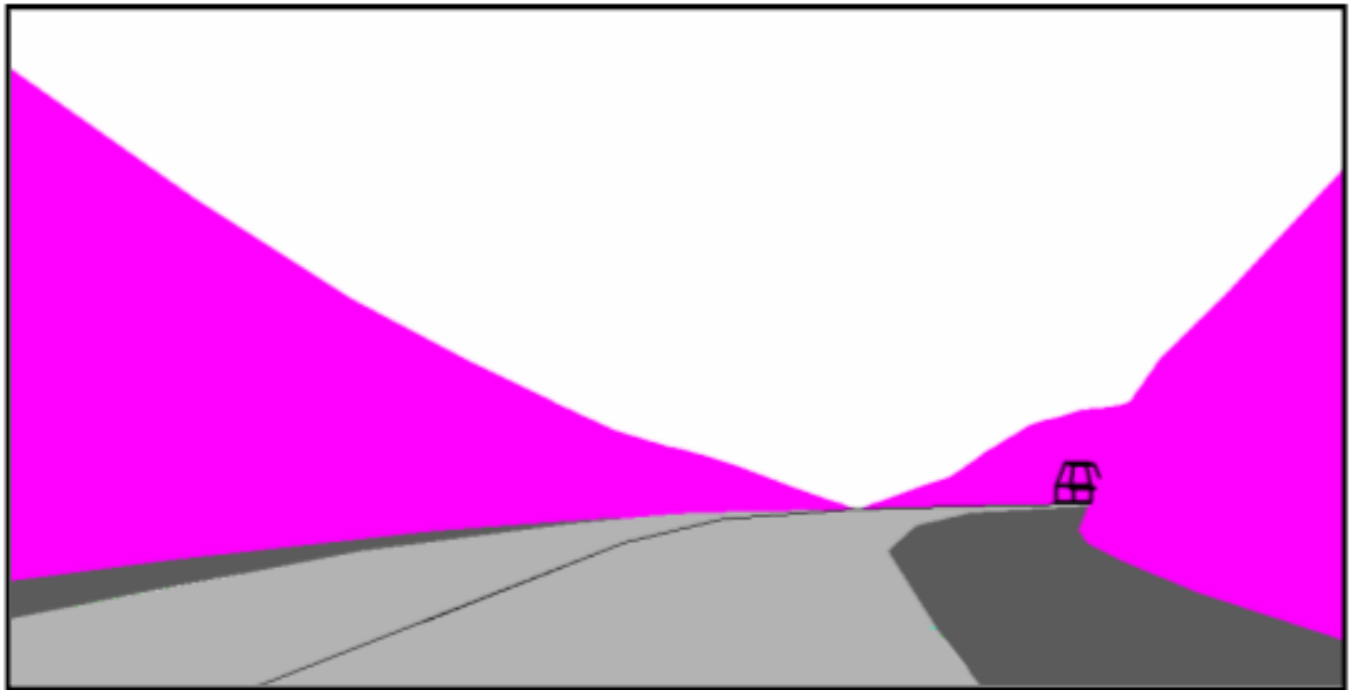
Perspective view from a station of a two-way two-lane undivided highway where both ASSD and APSD are adequate

Applications



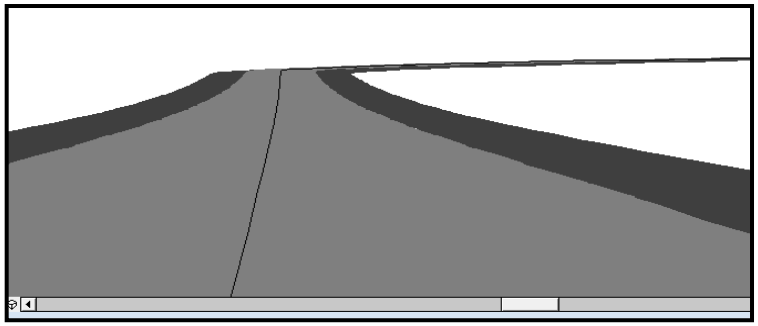
Perspective view from a station of a divided highway where ASSD is adequate

Applications

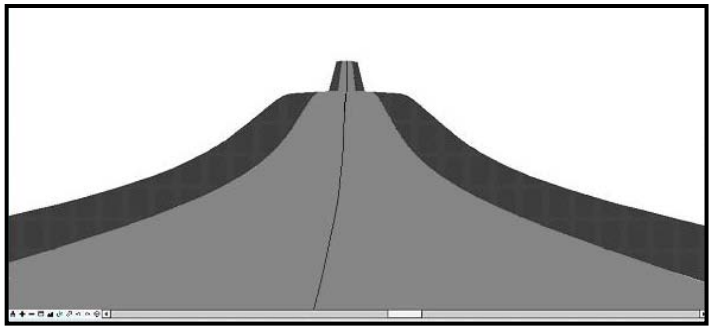


Perspective view from a station of a two-way two-lane undivided highway where ASSD is adequate but APSD is not

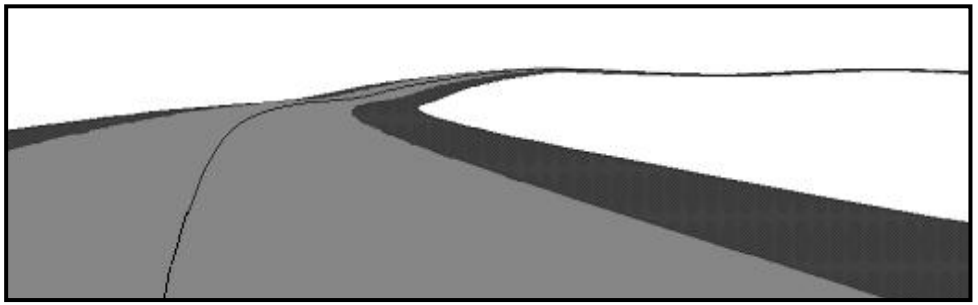
Applications



Optical alignment breakage due to small horizontal curve



Hidden dip at horizontal tangent



Flutter at horizontal curve

Conclusions

H11 system gives its operator the capability to:

- ✓ **“travel”** all along a new project and evaluate its spatial alignment, its consistency and its visibility conditions during the **preliminary** design
- ✓ use a **quantitative** criterion when evaluating the perspective images
- ✓ **directly** localize the element that restricts driver’s visibility at any station

Thank you for your attention!

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