MOTORWAY A88 FALAISE-SEES: AN INNOVATING GEOMETRICAL DESIGN BY EGIS, DESIGNER FOR THE PROJECT

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SUMMARY

Issues with standards on the project

In the context of the A88 Motorway concession between the cities of Falaise and Sées in France, the highway design team was confronted at the onset of the design work with a basic sight distance problem on the fast lane (used for overtaking) at critical points.

Indeed, ICTAAL[1] 2000 states that motorway users must have good sight of the vehicles travelling on the fast lane and the slow lane (hardshoulder) at critical points, where speed differences are greatest and the risk of conflicts or accidents is increased. The alignment of the A88 Motorway includes radii of 1500m to 2500m which restrict the sight distance at roadside objects and cut slopes.

In order to comprehend these problems from a functional perspective, an original and innovative method was developed to justify sight conditions by analysing the global travel data taking into account the road sections upstream and downstream of the project. In order to visualise the perception of the travel on these sections, an innovative modelling tool was developed: site recognition by a video film programme. The video film contains a safety analysis of the path of the driver on the upstream and downstream sections of the motorway. A video film assembly ensures we see through the driver's eyes dynamically while driving along the alignment, together with a comment from the expert.

Conclusions on the implemented methodology

A strict compliance to the standards would have prescribed widening the central reserve by 2-3m to satisfy the sight distance. However, the global approach implemented showed that the strict application of this extra-width was actually not needed, or could even increase the safety hazard in this particular context. In fact, the study showed that curve widening would create a dangerous situation where the driver would be encouraged to drive faster, not only in the event of fog or snow.

In the end, a balance was reached between the proposed geometrical road improvements to meet the standards and the interpretation of the behaviour of the driver using the motorway. The proposed road improvements were accepted by the Highway Authority. The perception of the infrastructure by the user, whose speed can be substantially controlled by road improvements, justified the approach about visibility and legibility compared to the over-comfort situation deemed unsafe.

[1] ICTAAL 2000. Instructions sur les Conditions Techniques d'Aménagement des Autoroutes de Liaison (2000). French rural motorway design standard.

1. INTRODUCTION

In August 2008, the Government entrusted the concession of the A88 Motorway from Falaise to Sées to ALICORNE, a private consortium of investors and contractors. These contractors, grouped into a construction joint venture named GIE A88, are responsible for the design and construction of the motorway, including all fixed operating equipment. This joint venture relies on the competence of consultant Egis to manage the design for the project.

The project is implemented in a special context: a short duration of 26 months, an old project already consulted by the Government, and significant land constraints (land expropriations and regroupings carried out, numerous ecologically sensitive and protected sites), which left little room for alignment modifications. An innovative design methodology was thus set up in order to justify the adequacy of the motorway cross-sections and the proposed restraint systems with the regulations and the safety of the user.

2. THE REGULATION CHALLENGES OF THE PROJECT

The conceded section of the A88 Motorway between Falaise and Sées consists of an existing section to be developed between Argentan Sud and Sées, as well as an approximately 30km-long section to be built between Falaise Ouest and Argentan Sud.

The Ministerial approval of the “Avant Projet Sommaire Modificatif” (equivalent to Stage 1 scheme assessment in the UK) of October 2, 2008 underlined the lack of visibility on the fast lane at critical points. As part of a request for departure from standard, the approval was subject to “more complete and detailed studies” of visibility conditions at the four junction points of the project (interchanges of Falaise Ouest, Falaise Sud, Nécy and Argentan Ouest).

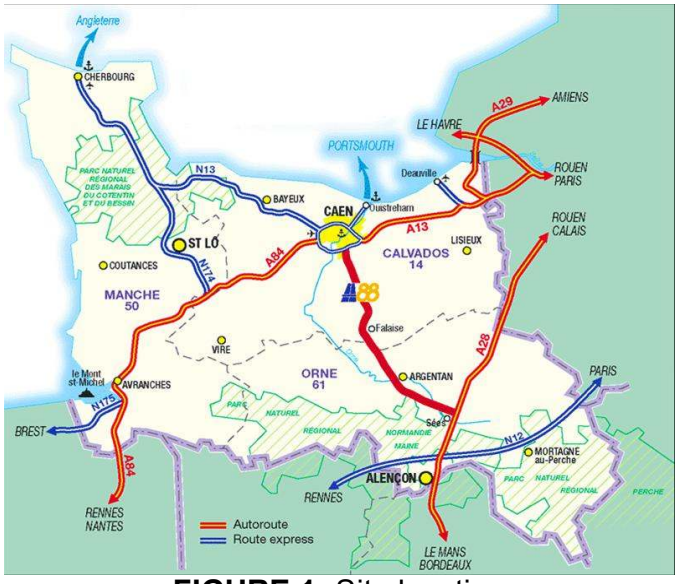


FIGURE 1- Site location

Indeed, ICTAAL 2000 standard imposes that users of the motorways should have good perception of the vehicles circulating on the fast lane and the slow lane at critical points, where the speed differentials can be high and the risk of conflicts and accidents are more important. The ICTAAL standard does not authorize a departure from standard to a lower sight distance at these critical points. However, the A88 Motorway comprises horizontal radii of 1500 to 2500m which limit the sight distance given the sight obstruction created by the concrete safety barriers in the central reserve for the vehicles circulating on the fast lane.
The objective of the notification for departure from standard requested by the Government was thus to present the improvements proposed in the central reserve at junctions of the A88 Motorway, and to show that those are well in adequacy with the requirements of safety regulations.

For that, Egis worked in collaboration with SETRA[2] to produce this file and developed an original and innovative method based on the global travel path to justify the sight distance conditions.

3. AN ORIGINAL METHODOLOGY DEVELOPED BY EGIS

3.1. Geographical context

The A88 Motorway section to be built is located between two motorway sections already in operation:
- The northern section, 25km long, connecting Caen to Falaise Ouest; it is a Trunk road (RN 158) with 2x2 lanes and separated carriageways comprising long straight alignments with two lanes of 3.50m in each direction;
- The southern section, 14km long, connecting Argentan Sud to Sées; it is a Motorway with 2x2 lanes, integrated into the concession of the A88, and with a more sinuous layout comprising a 3.50m-wide slow lane and a 3m-wide fast lane in each direction of travel.

[2] Service technique des routes et des autoroutes. French Highways Agency control body.

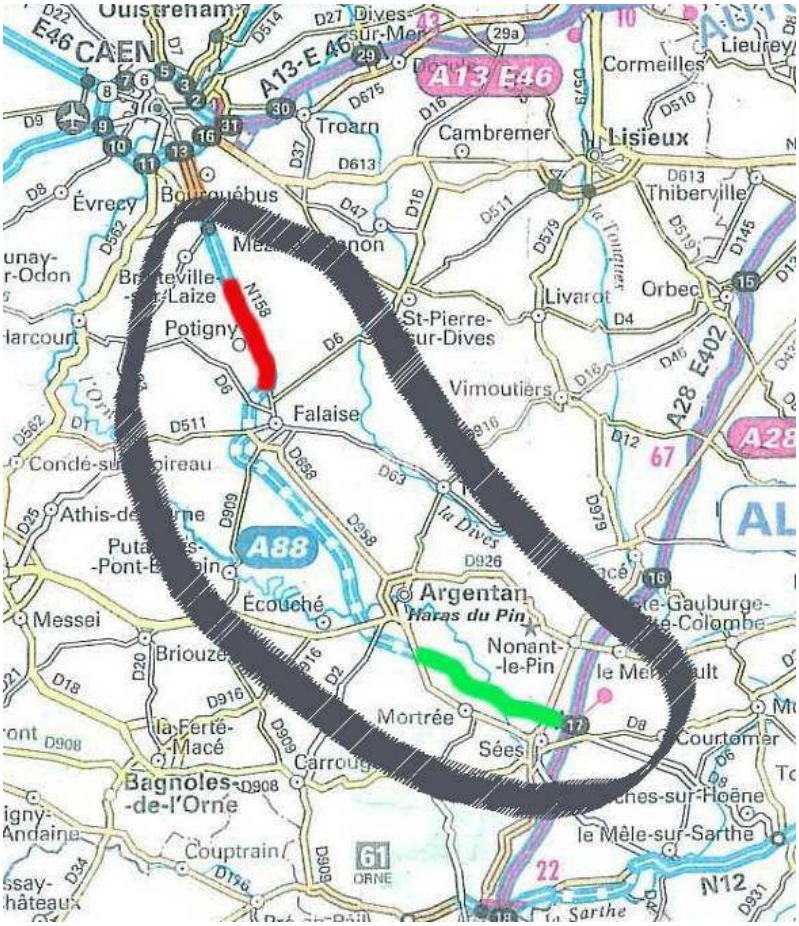


FIGURE 2- Location on road map

3.2. Originality of the initiative

The originality of the initiative is a will to apprehend the project in a global way, by taking into account the northern and southern sections. Indeed, these sections form part, together with the section Falaise/Argentan, of the same highway route which connects Caen to Sées. The perception of the infrastructure by the user who travels on this section from one end to the other is thus conditioned by the perception of the start of the route, whether he comes from Caen or Sées. Hence the statement of a principle which was used to support the discussion for the development of the request for departure from standard: *the designer of the section Falaise Ouest/Argentan Sud, which has similar features to the existing section between Argentan Sud and Sées, must aim for a global coherence of the whole route, so that the user does not need to adapt their behaviour while travelling from one section to the other, because that would jeopardise safety*.

The strategy for the preparation of the request for departure from standard, complementary to the Stage 1 Scheme Assessment reports for the motorway was the following one:

- Alignment design: horizontal alignment, vertical alignment, cross-section, in accordance with the usual contents of a motorway scheme assessment report;

- Deduction of sight distances in relation to practiced speeds on the mainline at each critical point on the fast lane (and the slow lane), and the corresponding sight distance requirements derived by calculation;
- Comparison with the sight distances actually provided, given the roadside sight obstructions, the vertical alignment and other particular features of the project;
- Identification of the potential departures and suggestion of corrective technical solutions by modification of the alignment or proposed improvements.

3.3. Design aide using a DVD film

An innovating tool was developed in order to improve the perception of the route on the upstream and downstream sections of the motorway. The designer prepared a site survey on DVD with the assistance of a professional video maker. It contains a safety analysis along the travel path of the user on the north and south sections.

4. A CUTTING EDGE TECHNOLOGY TO MAKE A TECHNICAL FILM

4.1. Description of the on-board equipment

FIGURE 3-PHOTO 3: Description of the on-board equipment

The on-board equipment was installed in the vehicle.
The equipment comprised:
- Digital on-board camera of type “SONY HDR-FX7E”;
- Long life batteries (6h);
- Lens at a height of 1.15m above the road surface;
- Sight line directed at the central reserve;
- The eye positioned at an offset of 2m from the right-hand-side of the lane.

4.2. Taking into account human factors

The video maker was driving and acted as the “average” user whose behaviour was analysed on the upstream and downstream sections.
An assessment of the human factors, landscape and alignment perception by the driver using written comments thus follows the images of the road. This film constitutes one of the appendices of the request for departure from standard, of which it forms an integral part.

4.3. Commented video

The video screen shows simultaneously, the filmed travelled path viewed by the driver, the location along the vertical alignment at the bottom of the screen and the comments from the Egis experts on the right hand-side of the screen.

The video produced is presented in the form of a film. The extracts hereafter included in this article correspond to screen shots.

FIGURE 4a- Screen short from the video

FIGURE 4b- Screen short from the video

FIGURE 4c- Screen short from the video

5. ALIGNMENT DESIGN

5.1. Calculation of Sight Distances

Egis furthermore carried out all sight distance calculations on the mainline at the various critical points, using a specific software developed in-house. This software enables the calculation of sight distance on the mainline and at motorway entrance/exit points.

Thanks to this tool, one can also change the cross-section dimensions (widths of hardshoulders for example) to reach the sight distance limits needed.

Autoroutes de liaison : calcul des distances de visibilité en courbe en plan unique (cercle)

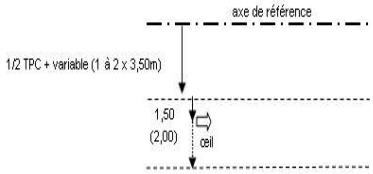
egis route

Observateur

Calcul : distances de visibilité en plan sur une sortie, sur une entrée d'autoroute et sur un obstacle en section courante (référence ICTAAL 2000 chapitre 2 Visibilité).

Le fichier sous forme de tableau permet, de façon transparente, de calculer les distances de visibilité souhaitées.
Voir "Méthode Calcul Visibilité" et "Exemple graphique" en cliquant sur les boutons correspondants.

Les 12 autres boutons permettent d'accéder aux calculs en fonction du cas qui se présente.



Méthode Calcul Visibilité

Exemple graphique

Visibilité sur sortie

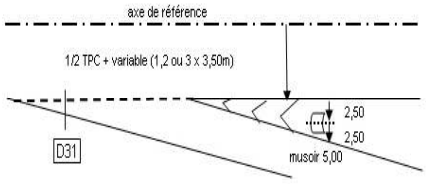
Point observé en sortie

Sortie Courbe à Gauche 2 voies

Sortie Courbe à Droite 2 voies

Sortie Courbe à Gauche 3 voies

Sortie Courbe à Droite 3 voies



Visibilité sur entrée

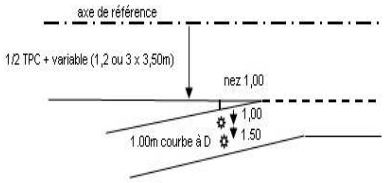
Point observé sur entrée

Entrée Courbe à Gauche 2 voies

Entrée Courbe à Droite 2 voies

Entrée Courbe à Gauche 3 voies

Entrée Courbe à Droite 3 voies



Visibilité en section courante

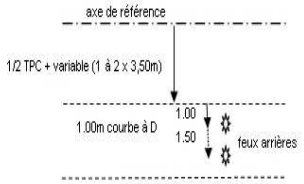
Point observé en section courante

Section courante Courbe Gauche 2 voies

Section courante Courbe Droite 2 voies

Section courante Courbe Gauche 3 voies

Section courante Courbe Droite 3 voies



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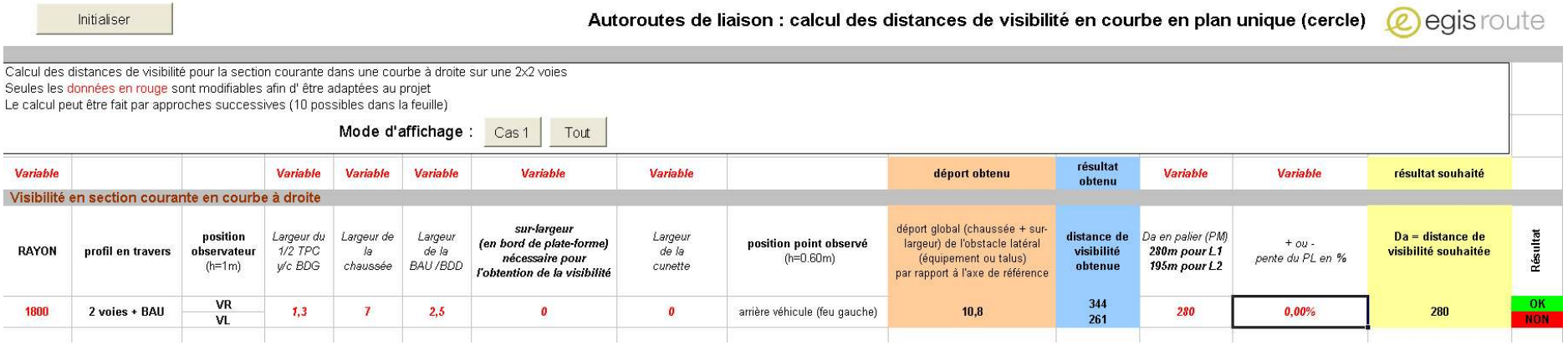

FIGURE 5- Software for the calculation of sight distances

6. REQUEST FOR DEPARTURE FROM STANDARDS

6.1. Motorway standards

A strict application of the ICTAAL 2000 would have required prescription of widening of the central reserve by 2-3m in order to increase sight distance on the fast lane. However, a global approach to the route, associated with a comprehensive analysis of each junction point, allowed to show that the strict application of these extra-widths was not actually needed, or could even be dangerous in this particular context.

In addition to the fact that in the event of fog or snow these extra-widths could prove dangerous, the study shows that they would create a situation of over-comfort encouraging the driver to drive faster. Moreover, the analysis of the northern section showed that the user already tended to drive faster than allowed to: it was thus noted a V_{85}[3] speed of about 130 to 135km/h, whereas this section, classified as a Trunk road, is limited to 110km/h. A hazardous situation would be created for a user travelling from south to north up to Caen if nothing was undertaken to encourage them to slow down when they enter this section.

6.2. Type of improvements selected

- It is thus necessary to avoid, on the section to be constructed, improvements creating a situation of over-comfort and encouraging the user to accelerate, as would constitute in first approach the extra-widths of central reserve at the four critical points selected.

In answer, it was thus advised to modify the couple geometry/roadside equipment of some links, to try to achieve the goal of the standard, by checking systematically that the legibility of approaches is satisfactory. This objective of research of the sight distance relates both the mainline itself as well as the mainline at critical access points to the motorway.

[3] V85 : speed below which 85% of vehicles drive in fluid traffic conditions (free vehicles).

The graphic synthesis of proposed improvements can be summarised hereafter.

PK			0,5	5	10-10,5	22,5-23
			DIFFUSEUR FALAISE OUEST	½ DIFFUSEUR FALAISE SUD	DIFFUSEUR DE NECY - BPV	VIADUC - DIFFUSEUR D'ARGENTAN OUEST
			R 1800	R 1800	R 2700	Viaduc + R 2700
Proposition finale	*Visibilité Sens Caen-Sées*	*VR*	- Changement de la DBA par une glissière métallique double en TPC - Bande médiane de 0,80 m au lieu de 0,60 m pour supporter la DE2 au droit de l'OA et réduction de 10 cm de largeur de BAU sur OA. - Limitation à 110 km/h jusqu'au PK 1,7 tant que la section amont est à 110 km/h	Aucun aménagement	Aucun aménagement	Aucun aménagement
	Visibilité Sens Sées-Caen	*VR*	Aucun aménagement	- Recalage de la boucle du diffuseur sens diffuseur --> Caen par un R60 en amont du R1800 (respect des longueurs d'accélération et de l'ICTAAL 2000)	- Soins particuliers du traitement de fuseau (sens Sées-Caen) pour ne pas créer de départ de trajectoire sur la section courante. - Voie d'entrecroisement avec la sortie vers Nécy.	- Surlargeur de 0,5 m de BDG sur un linéaire de 1200 m, en respectant les points d'application (origine, fin) vue au § 5.4.

. **FIGURE 6**- Synthesis of improvements

At the first interchange of Falaise Ouest, which is connected to the end of the existing section, it was proposed to install metal safety barriers in the central reserve to reduce the screening effect and improve visibility.

At the half-interchange of Falaise Sud, the link road merge was modified by moving the early entrance point (back of nose at E=1m) to the start of the 1800m radius curve in order to increase the visibility on a vehicle located on the merge taper. Indeed, moving the start of the link road merge towards the centre of the curve in plan allowed lengthening of the sight distance by being in the point of inflection of the preceding spirals. This approach considered that the user whose attention is attracted by the traffic flows at the interchange would decelerate temporarily and sufficiently before the curve.

For the critical point comprising the set Nécy interchange-mainline toll plaza, the study, as regards to safety, proposed a weaving lane between the end of the toll plaza taper and the diverge. This provision enables the user to limit their speed in relation to the length of the taper, the length of the weaving lane and the number of toll lanes, while keeping a good perception of signs and markings. Signs and markings located directly at the exit of toll lanes effectively draw the attention of the driver over a sufficient time to avoid increasing their speed as they would do on the mainline.

Finally, for the Argentan Ouest interchange, an extra-width of 0.5m of the inner hardstrip was provided to satisfy the sight distance condition which was equated to the stopping sight distance for the estimated speed. The installation of concrete barriers in the central reserve, by the curbing effect created, aims at matching the visibility obtained with the distance just sufficient to avoid generating a zone of excess visibility, which would be unsafe given the design philosophy retained for the whole of the section.

CONCLUSION

In conclusion, the improvements proposed and selected by the Highway Authority constitute a right balance between the regulatory geometrical requirements and the real behaviour of the user on the motorway. The perception of the infrastructure by the user, whose speed can be substantially controlled by improvements, has justified the visibility and legibility approach used in relation to the over-comfort situation deemed unsafe.

REFERENCES

1. ICTAAL 2000. Instructions sur les conditions techniques d'aménagement des autoroutes de liaison
2. SETRA: Service technique des routes et des autoroutes.