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SEARCH FUNDAMENTAL PARAMETERS, TRANSVERSE REPAIR COEFFICIENT USED RDM6

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ABSTRACT

This project entitled Design, Sizing and Planning of the works of a reinforced concrete girder bridge was carried out in Tunisia. The objective of this work is based on the determination of the fundamental parameters and the determination of the transverse repair coefficient (TRC) for the dimensioning of the various elements of the Apron such as beams, spacer and slab. In this work, we used two methods or (approaches) for the determination of the geometrical characteristics of the beams. The study led to the determination of the various fundamental parameters which are the parameters of bracing and the torsion parameter. The method or approach by the RDM6 software of the finite element module, for which the geometrical characteristics of the different sections have been obtained by the following formula:

B_{moy} (m^2) = $B_{appui}C_1 + B_{centrale}C_2$;

C_1 and C_2 the interpolation coefficients which describe the variation of the section of the beam as a function of the length and when d= 0.5 m.

$C_1 = \frac{1}{3} + \frac{4}{3*Lp} = \frac{1}{3} + \frac{4}{3*21} = 0.3968$; $C_2 = \frac{2}{3} - \frac{4}{3*Lp} = \frac{2}{3} - \frac{4}{3*21} = 0.6032$

These, for bending inertia and also for torsional inertia. Thus the torsion parameter $\alpha = 0.71$ and the spacing parameter $\theta = 1.31$

Key words: Parameters; Fundamentals; Characteristics; Geometric; Coefficient; Beam; Rigidity; Section.

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1. INTRODUCTION

Economic development remains a major preoccupation in all countries. This development often follows the creation of roads, railways or river networks. In order to improve and facilitate the movements of its population, the Government of Tunisia decided to build a 3 x 3-lane motorway between Bousalem and Beja. Hence the importance and pertinence of our study theme of the study of a Great Hydraulic Work.

In this work, we propose to carry out the detailed study of a bridge made of reinforced concrete composed of the different elements such as beams, slab, strut, abutment, support apparatus, stack And foundations. All this being done by taking care to multiply the various estimated loads on the weighting coefficients in order to ensure its stability and the safety of its users.

2. LITERATURE / THEORETICAL UNDERPINNING

Many tasks have been carried out (huge work has been done on the calculation of the fundamental parameters and the determination of the Coefficient of Transversal Distribution) in the dimensioning of the Road Bridges. Bridges are works of art for which a roadway crosses a natural obstacle or other roads, land, river or sea. In practice, it is called Works of Art to designate a Bridge. In addition, the Bridges, Raiders and Buses have been the subject of careful studies carried out by several researchers such as:

Bernaert (May 1969), "the calculation at the limit states of slabs and planar structures». Annals ITBBTP, No. 257. Calgaro and Cortade (2005), Applications of Eurocode 2: calculation of buildings in concrete. PERCHAT and ROUX (2000, 1993), BAEL 91 and UTD associates, Practice BAEL 91. BEN (2008), the Art of Building »Volume 1: Conception, « Art Course »Volume 2: Dimensioning.

3. METHODOLOGY

3.1. Geographic location

This is a road crossing on the Oued Zarga-Rhayette of 31.5 m of width located in the region of Bousalem. The axis of the structure has a right angle rather to the axis of the channel as shown in the map below.

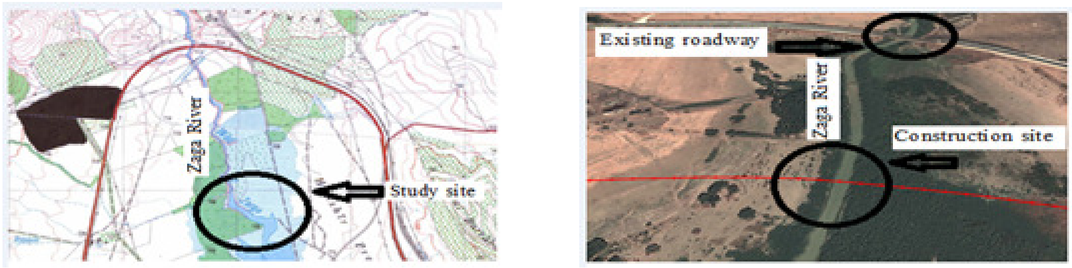

Figure 1 Location plan and construction site

The method of Guyom-Massonnet which is defined as a method of calculation of slabs or beams networks. This method is stated according to two fundamental principles which are the followings:

- To substitute form the real bridge a bridge with a continuous structure which has the same average rigidity in flexion and torsion as the real structure.
- Approximately analyze the effect of the transverse distribution of the tanks assuming that this distribution is the same as if the distribution of the loads along the axis of the bridge is sinusoidal.

The determination of the fundamental parameters depends on the different aspects of the construction such as:

- The longitudinal design
- The transverse design
- The geometry of the sections of the beams

Which led us to carry out the study for an independent span of span (Lc) of our work (according to the longitudinal design, the roll able width "Lr "According to the cross-section and the slab acting as the intermediate spaces and also the spacing between the beams" b0 ")

3.2. Longitudinal design of the deck

According to the hydrological studies and the topography of the area, we have gone for a reinforced concrete girder bridge of 84.27 m length with 4 independent spans, thus two spans of 21.34 m of axis in axis and two spans of shore of 20.67m. This allows us to determine the following characteristics:

- Intermediate span length: L_t = 21.34 m
- Edge which is taken equal: d= 0.5 m
- calculation length equal: L_C = 21.34 -2 x 05 - 2 x 0.17 = 20 m
- Beam length: L_P = 21 m

Below is the longitudinal section of the proposed bridge.

3.3. Transversal design

The width of the bridge depends on the road requirements. The road crossing this structure is equipped with 3x3 lanes, one lane will be blocked, and this lane will be unblocked as traffic increases. A bridge with two independent decks of 14.75 m each, separated by a 2 m grating, will be considered and a part of the deck will be worked on. An emergency stopping strip of 2 m and a left stray strip of 1 m are provided on each apron width and also a normal BN4-type barrier placed on a set of cornices and against a cornice of 0, 75 m on the right bank and a 0.5 m safety slide located on the left bank.

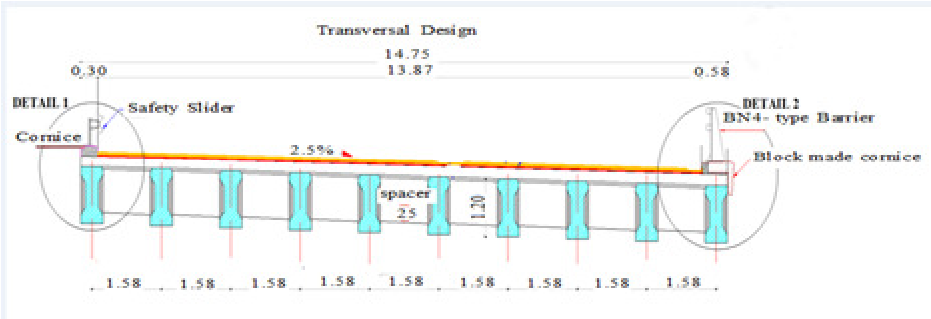

Figure 3 Cross section of the bridge

3.4. Methods of experimentation

In our case, the absence of intermediate spacers in the cross-section of the bridge is deformable; hence the Guyom-Massonnet method is used for the calculation of the longitudinal moments taken up by the beams and the beams. Transverse moments taken up by the slab.

Calculation of the fundamental parameters by the RDM6 software approach

The choice of the cross section of the beam allows us to calculate the geometric characteristics, to facilitate the calculations we used the finite element module of the RDM6 software. Since the beam along its length is variable, which leads us to work on two sections: central and support. In addition, it is imperative to determine the average geometric characteristics of the section. The fundamental parameters are summarized in the determination of the torsion parameter α and the spacing parameter θ which serve to define the behavior of the bridge. To determine these, we will need their stiffness's which are determined as follows:

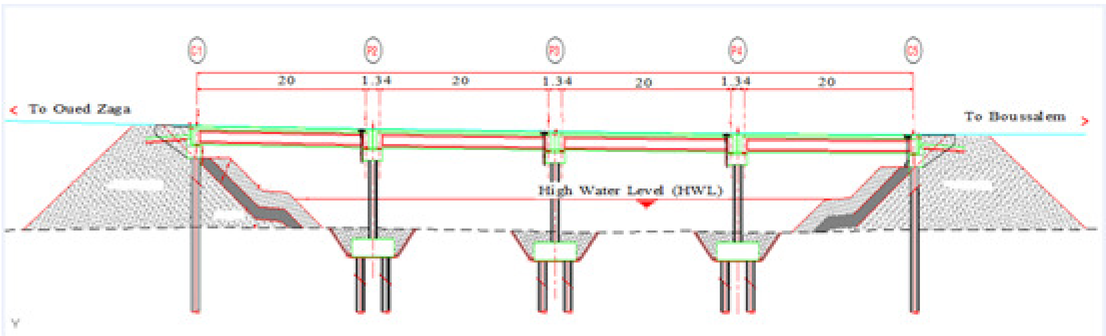

Figure 2 Longitudinal section of the bridge

- Flexion stiffness : Beam: $\rho_P = \frac{E*Ip}{b1}$; Spacer: $\rho_E = \frac{E*IE}{L1}$

- torsion stiffness : Beam: $\gamma_P = \frac{E*Kp}{2xb1}$; Spacer: $\gamma E = \frac{E*IE}{L1}$

The parameters are:

- **Torsion parameter**: $\alpha = \frac{\gamma P + \gamma E}{2\sqrt{\rho p x \rho E}}$; - **Spacing parameter**: $\theta = \frac{b}{L}\sqrt[4]{\frac{\rho p}{\rho E}}$

Calculation of the Transversal Distribution Coefficient (TDC)

- The calculation of the **TDC** coefficient depends on the number of main beams, the position of the beams in relation to Axis of the cross-section and a coefficient K determined from the table Guyom-Massonnet.

3.5. Determination of the lines of influences

Our study in the determination of the lines of influences will be done on the edge beam and the intermediate beam determined only after three interpolations:

- Interpolation on (α)
- Interpolation on (θ)
- Interpolation on (Y), which is defined as the distance in the transverse direction between the vertical axis of the bridge and that of the beam to be studied

Intermediate beam and edge beam

The abscissa (y) of the intermediate beam and edge beam is determined as follows:

$$Y = \frac{0.79}{7.375} * b = 0.11 * b \quad ; \quad Y = \frac{7.11}{7.375} * b = 0.96 * b$$

Since we have the values of bracing, we will choose the values in the table of Guyom-Massonnet and then we carry out the interpolations.

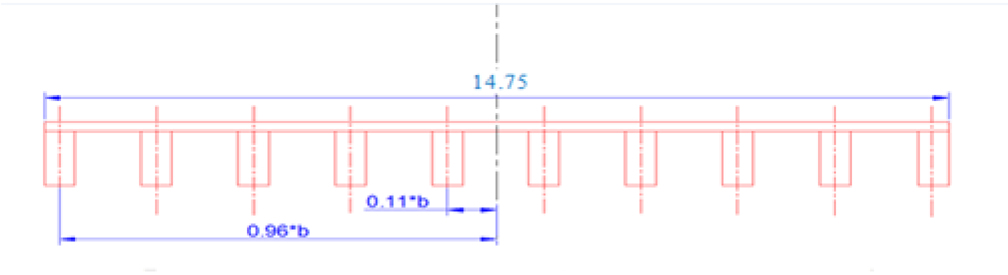

Figure 4 Position of the abscissa on the cross-section

- Loading system and arrangement
- Load case AL

This system consists of uniformly distribute loads of varying intensity depending on the overloaded length and which correspond to one or more lines of vehicles when stationary on the bridge.

The AL load according to the loading rules is placed in the most unfavorable manner. For this purpose and because of the variation of A_1 and the loading width LAL, the following cases (one, two, three and four loaded channels) will be tested. We will make the cases of loadings for the shore beam and that of the intermediate beam (see Appendix 1).

With: the coefficient K which is:

$$K_{AL} = \frac{\text{Transversely area covered by AL on the line ^ influence K}}{\text{width covered transversely AL}} = \frac{\text{WAL}}{\text{LAL}}$$

Such that WAL which is the area of the influence line corresponding to the load divided by the width of the load is determined by the AutoCAD software or by the decomposition of the surface into elementary surfaces.

Load case Bc

For Bc loading, the longitudinal layout requires a maximum of two trucks per lane and as many lanes as the number of lanes in the transverse direction. Since Bc coefficient varies, we will try 4 files Bc; we will place them on the loadable width to obtain the case of the most unfavorable loading, while respecting the characteristics of Bc convoy: the distance between file of Bc is 2 m, the Distance between two lines of Bc is 0.5 m and leave a distance of 0.25 m between the edge of the sidewalk and the first line of wheels, if there are the restraints, a distance of 0.75 m is allowed. The loads of the influence lines of the edge beam and of the intermediate will be loaded. With the Ki which are the ordinates at the location of the wheels, they are determined graphically in the AutoCAD software.

- Load case MC120

For this type of load, only one vehicle is used in the transverse direction regardless of the width of the roadway and has two tracks with the following characteristics: the distance between two tracks is 2.30 m and the distance between the tracks a caterpillar is 1 m.

4. RESULTS

After this study, it appears that the values of the fundamental parameters approach the RDM6 software and determination of transverse distribution coefficient of beams rives, Intermediate and beam model are presented in the following tables and figures:

Geometrical characteristics

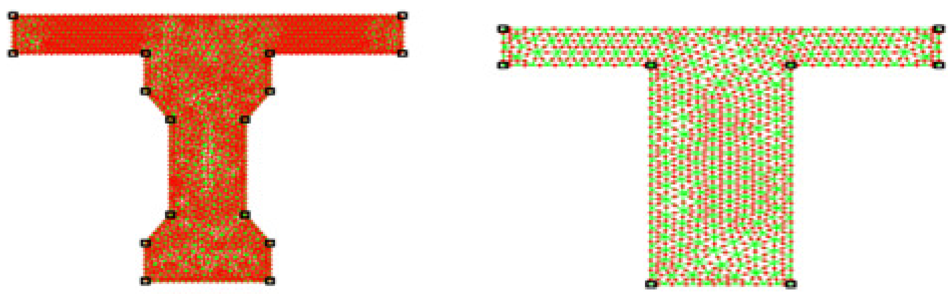

Figure 5 Quantification of the central section and the supporting section elements

Table 1 Results of geometrical characteristics in Central section

Designation	Geometrical characteristics	Beam without slabs	Beam with slabs
Central Section	B (m^2)	0.47	0.786
Flexion Inertia	I (m^4)	0.0671	0.1608
Torsion Inertia	Γ (m^4)	0.015	0.02565

Table 2 Results of geometrical characteristics in support section

Designation	Geometrical characteristics	without slabs	with slabs
Support Section	B (m^2)	0.6	0.916
Flexion Inertia	I (m^4)	0.0719	0.17447
torsion Inertia	Γ (m^4)	0.037	0.0498

Table 3 Results of average geometric characteristics

Average characteristics	Formula	without slabs	with slabs
B_{moy} (m^2)	$B_{appui} C_1 + B_{centrale} C_2$	0.5216	0.8376
I_{moy} (m^4)	$I_{appui} C_1 + I_{centrale} C_2$	0.069	0.1662
Γ_{moy} (m^4)	$\Gamma_{appui} C_1 + \Gamma_{centrale} C_2$	0.0237	0.0352

- Fundamental parameters

Table 4 Results of fundamental parameters

Fundamental parameters							
B_{moy} (m^2)	I_{moy} (m^4)	Γ_{moy} (m^4)	ρ_P	$\rho_E = \gamma_E$	γ_P	α	θ
0.8376	0.1662	0.0352	0.1052*E	0.000666*E	0.011487*E	0.71	1.31

- Intermediate beam
- Interpolation on (Y), α et θ

(Y) is between Y= 0 and Y= $\frac{1}{4} * b$ therefore $Y_{0.11b} = 0.56*Y_{0.25b} + 0.44*Y_0$

(α) is between 0 and 1 therefore : $K_\alpha = K_o + (K_1 - K_0)*\sqrt{\alpha}$

θ is between 1.3 and 1.4 therefore : $K_{\theta=1.31} = 0.9*K_{\theta=1.3} + 0.1*K_{\theta=1.4}$

Table 5 Results of the interpolation at the level of Intermediate beam

θ = 1.31 α = 0.72	**-b**	**-0.75*b**	**-0.5*b**	**-0.25*b**	**0**	**0.25*b**	**0.5*b**	**0.75*b**	**b**
y = 0.11*b	0.089064	0.248846	0.56588	1.158888	1.86965	1.9606	1.2974	0.68124	0.2933

Intermediate beam Influence line Interpolation

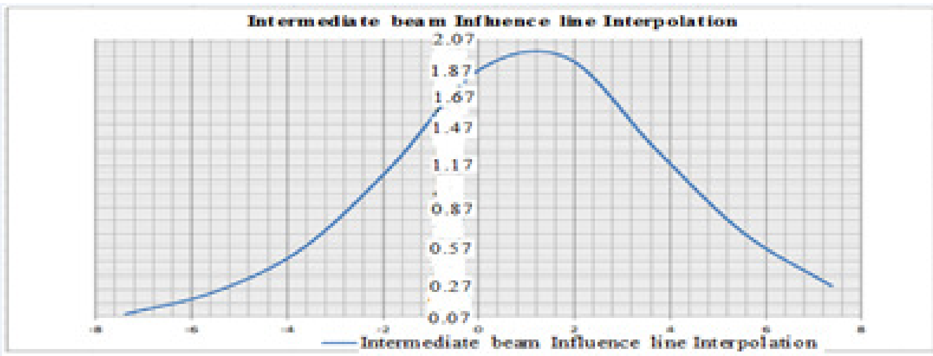

Figure 6 Intermediate beam Influence line Interpolation

- Edge Beam
- Interpolation on (Y), α et θ

(Y) is between Y= $\frac{3}{4}$ *b and Y= b therefore $Y_{0.96b} = 0.12*Y_{0.75b} + 0.88*Y_b$

(α)) is between 0 and 1 therefore : $K_\alpha = K_o + (K_1 - K_0)*\sqrt{\alpha}$

(θ)) is between 1.3 and 1.4 therefore : $K_{\theta=1.31} = 0,9*K_{\theta=1.3} + 0.1*K_{\theta=1.4}$

Table 6 Results of the interpolation at the edge beam

θ = 1.31 α = 0.72	-7.375	-5.53	-3.6875	-1.84375	0	1.84375	3.6875	5.53	7.375
y = 0.96*b	0.0241168	0.02594	0.0351809	0.064914	0.17976	0.478569	1.3255	3.142	6.0607

- Line of Influence edge beam

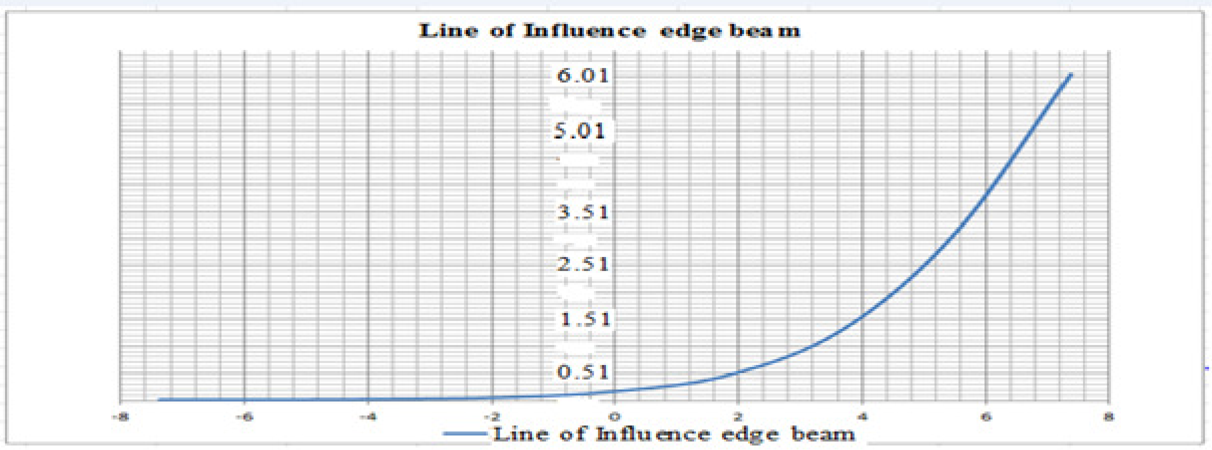

Figure 7 Line of Influence edge beam

- Load case A_L
- Intermediate beam

Table 7 Summary of the TDC beam intermediate Load case A_L

Loading case	**Coef a_1**	**Surface $W_{AL}(m^2)$**	**Coefficient $K_{AL} = \frac{wAL}{LAL}$**	**TDC $\eta_{AL} = \frac{KAL}{n}$**	**a_1* η_{AL}*L_{AL}**
1chanel (L_{AL}= 3.17 m)	1	6.0913	1.9215	0.192	0.6086
2chanels (L_{AL}= 6.34 m)	1	10.8817	1.7163	0.172	1.09048
3 chanels (L_{AL}= 9.51 m)	0.9	13.3058	1.399	0.1399	1.197
4 chanels (L_{AL}= 12.7m)	0.75	14.275	1.124	0.1124	1.071

From the table we find that the intermediate beam loaded is the worst case a_1x η_{AL}xL_{AL} = 1.197 is the max.

- Shore beam

Table 8 Summary of TDC shore beam in load case AL

Loading case	**Coef a_1**	**Surface $W_{AL}(m^2)$**	**Coefficient $K_{AL} = \frac{wAL}{LAL}$**	**TDC $\eta_{AL} = \frac{KAL}{n}$**	**a_1* η_{AL}*L_{AL}**
1 chanel (L_{AL}= 3.17m)	1	8.3478	2.633	0.2633	0.8347
2 chanels (L_{AL}= 6.34m)	1	10.0314	1.5822	0.15822	1.003
3 chanels (L_{AL}= 9.51m)	0.9	10.3407	1.0873	0.10873	0.931
4 chanels (L_{AL}= 12.7m)	0.75	10.4395	0.822	0.822	0.7829

According to the table we find that the 2nd chanel loaded is the worst case because a_1x η_{AL}*L_{AL} = 1.003 is the max.

- Loading case Bc
- Intermediate beam

Table 9 Summary of TDC intermediate beam load case Bc

Loading case	Disposition	Coef bc	Coefficient $K_{Bc} = \frac{\sum Ki}{2}$	TDC $\eta_{Bc} = \frac{KBc}{n}$	Bc* η_{Bc}
1file Bc	symmetrical arrangement	1.2	1.899	0.1899	0.228
	asymmetrical arrangement		1.778	0.1779	0.2135
2 files de Bc	symmetrical arrangement	1.1	3.461	0.3461	0.3807
	asymmetrical arrangement		3.452	0.3452	0.3798
3files de Bc	symmetrical arrangement	0.95	4.596	0.4596	0.4366
	asymmetrical arrangement		4.44	0.4441	0.422
4files de Bc	symmetrical arrangement	0.8	5.282	0.528	0.4221
	asymmetrical arrangement		5.277	0.528	0.422

- **Shore beam**

Table 10 Summary of TDC shore beam load case Bc

Loading case	Disposition	Coef bc	Coefficient $KBc = \frac{\sum Ki}{2}$	TDC $\eta Bc = \frac{KBc}{n}$	bcx ηBc
1file of Bc	one disposition	1.2	3.0556	0.30556	0.3667
2files of Bc	2 files of Bc(after 0.75m)	1.1	4.0033	0.4003	0.4404
3files of Bc	3 files of Bc	0.95	4.2445	0.42445	0.403
4files of Bc	4 files of Bc	0.8	4.3112	0.43112	0.3448

- load case MC120

Intermediate beam

Table 11 summary of TDC intermediate beam load case Mc120

Loading case	$K_{MC} = \frac{\sum Ki}{4}$	$\eta_{MC} = \frac{KMC}{n}$
First disposition	1.41	0.141
Second disposition	1.679	0.1679
Third disposition	1.5084	0.1508

Shore beam

Table 12 TDC summary shore beam load case MC120

Loading case	$K_{MC} = \frac{\sum Ki}{4}$	$\eta_{MC} = \frac{KMC}{n}$
2 bits at 0.5m of the GBA	2.3934	0.23934

Beam Model

Table 13 Summary of beam TDC s Model following loads

load	TDC	Characteristics	Most adverse case
Al	0.1399	$a_l = 0.9$ et $L_{AL} = 9.51$ m	3 loaded channels
Bc	0.4003	bc = 1.1 P = 12t. 6t	2files of Bc
Mc_{120}	0.23934	P =110t. L_{Mc} = 1m	2 bits at 0.5m of the GBA

5. DISCUSSION

After carrying out the various calculations according to the Standards, SETRA documents and UTD (Unified Technical Documents), it follows:

- The various geometrical characteristics features of the two sections are different. This is due to the variation of the section along the beam. The following variations are observed:
  - A variation of 14.19 % between the air of the central section and the air of the section;
  - A variation of 7.84 % between the flexural inertia of the central section and the flexural inertia of the support section;
- A variation of 48.45 % between the torsional inertia of the central section and the torsional inertia of the bearing section.

It is therefore imperative to determine the average geometrical characteristics of the section in order to optimize the reinforcement of the beam to different sections

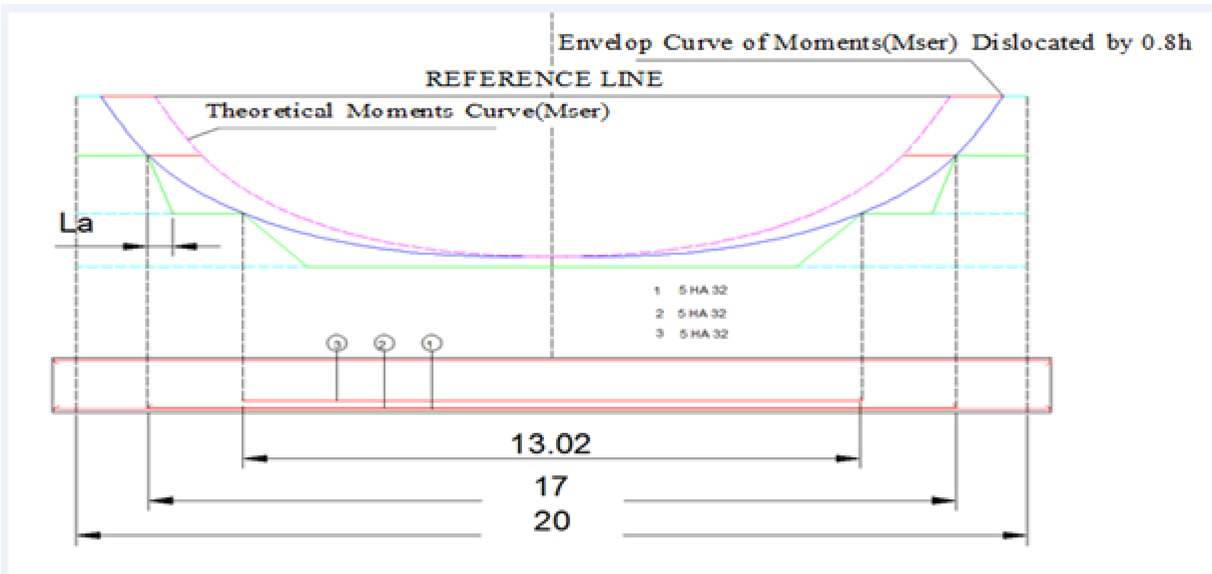

Figure 8 Barrel

The reinforcement consists of several beds; the time taken by each of the beds is plotted on the diagram of the bending moments. The intersection of these resistant moment lines with the envelope curve determines the bar stops.

- According to the table:7 we find that 2 loads is the worst case because car $a_l x \eta_{AL} x L_{AL} = 1.003$ is the maximum for the Shore Beam and according to the table:8 we also find that for the intermediate beam loaded 3 times is the most Unfavorable because car a_l x $\eta_{AL} x L_{AL}$ = 1.197 is the max.
- The Ki are the ordinates at the location of the wheels, they are determined graphically in the AutoCAD software. From the table: 10 above we find that 2 rows of Bc is the worst case for the

Shore Beam because bc x ηBc = 0.4404 is the max and for the Intermediate Beams we find that 3 rows of Bc is the The worst case because bc x ηBc = 0.4366 is the max.

- By comparing the values TRC of these different beams, the most unfavorable values are derived to calculate a single model beam. Thus, the reinforcement will be the same as the other beams.

6. CONCLUSION

In this project, we were interested in the design, dimensioning and planning of execution and financial works of a crossing on Oued Zarga -Rhayette situated On the A3 motorway in the Bousalem area. During this project we tried to carry out a general and complete study of a structure and for this it was necessary to follow and study closely each step of design and dimensioning of the bridge to beam. From this it follows the calculation of the fundamental parameters by the RDM6 software approach and the determination of the Transversal Repartition Coefficient (TRC) of the various beams. The calculations of the different elements of our work are carried out by referring to the recommendations of SETRA and Based on the rules of the BAEL 91. In the end, the results obtained during this study pose the milestones constituting the fundamental parameters and the Transmission Coefficient of a Beam Model for the dimensioning of the beams of the structure.

7. PERSPECTIVES

- Calculation of the various stresses of the overloads and the permanent load
- Determination of the reinforcement of the different elements of the deck with reinforcement plan Use of the Euro code 2 for the calculation of the reinforced Concrete

8. IMPLICATION OF THE MODEL TO RESEARCH AND PRACTICE

- The creation of the mechanical and Resolution methods using ROBOT and RDM6 software.
- The drawing of the lines of influence with EXEL

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