TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

**ACTA TECHNICA NAPOCENSIS**

**Series: Applied Mathematics, Mechanics, and Engineering**
**Vol. 67, Issue II, June, 2024**

# CALCULUS OF A MONOBLOC DENTAL BRIDGE WITH TWO POLES AND TWO MISSING TEETH AS A BEAM, BY TRANSFER-MATRIX METHOD

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***Abstract:*** *This work is a continuation of the research and calculus for a dental bridge. Now, it is studied a monobloc dental bridge, with two poles at the two ends of the dental bridge and with two edentulous between the two poles. This monobloc dental bridge was assimilated with a statically indeterminate beam, that was considered to be embedded at the level of the two poles and with and with aggregation elements corresponding to the missing teeth, between the two poles. The calculus for this monobloc dental bridge was done by Transfer-Matrix Method (TMM), and the validation of the results was done by solving the same problem with the Clapeyron's three moments equation. TMM can be easily programmable, to facilitate the obtaining of results. In the future, experimental results will also be presented, which are hoped to validate the theoretical results obtained in this work through the TMM and through the classical calculus with Clapeyron's three moment equation.*

***Key words:*** *monobloc dental bridge, statically indeterminate beam, Transfer-Matrix Method (TMM), Clapeyron's three moments equation.*

## 1. INTRODUCTION

Dental restoration in dentistry and orthodontics is very important for health.

That is why the dental bridge is very often used even today, being a relatively easy dental device to make, under certain conditions of the existence of healthy pillar (poles) teeth or some implants, that can be used as pillar (poles) teeth, which support the aggregation elements, which form the body of the dental bridge.

The approaches to the calculus of the dental bridge, for different types of edentulous, considering different types of loads and similarities, were made in [26], [27], [28], [32] and [34].

This work is a continuation of the research and calculus for a monobloc dental bridge, with two poles at the two ends of the dental bridge and with two edentulous (missing teeth, gaps) between the two poles. This monobloc dental bridge was assimilated with a statically indeterminate beam that was considered to be embedded at the level of the two poles and with aggregation elements corresponding to the missing teeth, between the two poles.

The calculus of this dental bridge was done with the Transfer-Matrix Method (TMM), and the results validation was done by solving the problem with Clapeyron's three moments equation.

Bases of calculus with Transfer-Matrix and with Dirac's and Heaviside's functions and operators are presented in [14] and the classical for statically indeterminate beams calculus of Strength of Materials is given in [29] and [36].

[2] present the situation about field of health in rapport with dental bridges in England and Wales and [6] shows about the oral health in rural areas around Cluj-Napoca, Romania. [3] and [18] are good guides about diagnosis and treatment of conditions in oral pathology field and [15] present practical notions about the preparation of fixed unidentical prostheses. [11]

**Received**: 30.04.24; **Similarities**: 29.05.24: **Reviewed**: 31.05./22.05.24: **Accepted**:24.06.24.

present Co-Cr dental bridges bending fracture and in [12] shows experimental investigation about Co-Cr dental bridges bending fracture. In [13] present integrated construction and simulation for milling dental crowns and bridges. [16] gives experimental research results of tensile loaded composite materials and, [9] and [10] present studies about the bending behavior of a new sandwich composite material and for two other composite materials.

[1] present a histopathological zirconium dental implants study, three months after insertion in rabbit femur. In [4] shown an in-vitro comparative study using dye penetration, AFM, SEM and FTIR, in [7] is presented bio-ceramic study and in [5] shown a bio-ceramic endodontic sealers. [20] present a case report about enameloplasty in interdisciplinary treatment of dental injuries. [19] present coronary reconstructions, [17] and [21] look the design for dental bridge geometry after fatigue of zirconia and after cyclic loading in water. Buckling calculus for bio-composite sandwich bars is given in [23]. [37] present effects of mechanical behaviors and resistance for super translucent dental zirconia. Dental alloys research with cobalt-crom base is presented in [35]. Figures of graph partitioning by counting, sequence and layer matrices are presented in [30]. Transfer-Matrix Method for calculus of long cylinder tube is given in [8]. TMM calculus of mandible bone is presented in [22] and [33]. Bending beam on elastic environment by TMM is given in [24]. [31] shown a buckling calculus of straight bars on elastic environment by TMM for dental implants and another buckling calculus approach for of dental implant as a bar on elastic environment by TMM is presented in [25].

## 2. A MONOBLOC DENTAL BRIDGE WITH TWO POLES IN EXTREMITIES AND TWO MISSING TEETH BETWEEN THE TWO POLES, AS A BEAM

It is considered a dental bridge with two poles in extremities and two missing teeth between the two poles (Fig. 1.). It was considered that the three vertical forces (which were assumed to have the same magnitude) act in the following sections (as in Fig. 1.): the first vertical force acts in the section between the left pole and the first aggregation element (which replaces the first edentulous); the second force acts in the section between the two edentulous; the third force acts between the right pole and the second edentulous. It was also considered that the dental bridge is cast monobloc.

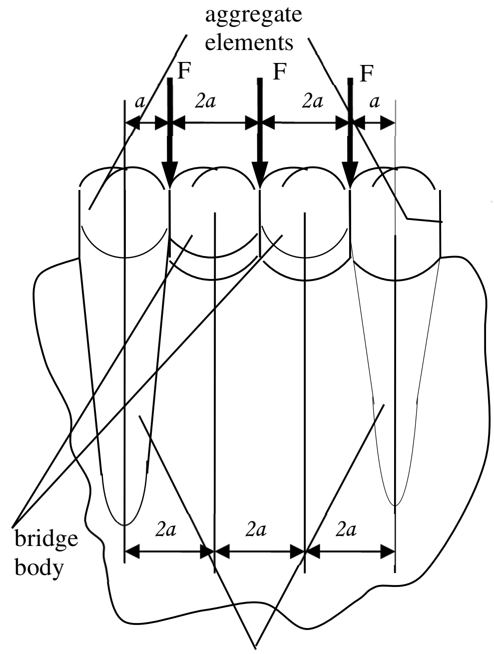


**Fig. 1.** Monobloc dental bridge with two poles on the extremities and two missing teeth between the two poles.

The monobloc dental bridge is considered assimilated with a beam, embedded at the level of the two poles and loaded with the three concentrated vertical forces, as in Fig. 1 and Fig. 2.

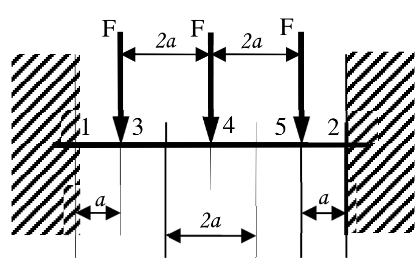


**Fig. 2.** Monobloc dental bridge from Fig. 1., as a beam

It is also considered that the distances between the forces are equal to each other and equal to *2a*, the distance from the embedment on the left to the first force is equal to *a*, as well as the distance between the last force and the embedment on the right, which have the value $a$ too.

## 3. CALCULUS OF A MONOBLOC DENTAL BRIDGE WITH TWO POLES ON THE EXTREMITIES AND TWO MISSING TEETH BETWEEN THE TWO POLES, AS AN EMBEDDED BEAM AT TWO ENDS, BY TMM

In [9] is presented the analytical calculus for a beam (as in Fig. 2.), by TMM, based on theory of Dirac's and Heaviside's functions and operators.

The three concentrated vertical loads, acting in the sections *3, 4, 5*, (as in Fig. 2.), give rise to a density of charge as in (1):

$$q(x) = -F\delta(x-a) - F\delta(x-3a) - F\delta(x-5a) \quad (1)$$

$\{U\}_x$ is a state vector associated at a current section $x$, with four elements as in (2):

$$\{U\}_x = \{v(x), \omega(x), T(x), M(x)\}^{-1} \quad (2)$$

when:

- $v(x)$ - is the arrow;
- $\omega(x)$ - is rotating;
- $T(x)$ - is the cutting force;
- $M(x)$ - is the bending moment.

The first section corresponding to left embedded support is noted with *0* and,we have the state vector $\{U\}_0$, as (3):

$$\{U\}_0 = \{v_0, \omega_0, T_0, M_0\}^{-1} \quad (3)$$

The matrix relation between the state vector of the current section $x$ and the state vector for the origin section *0*, $\{U\}_x$, is as (4):

$$\{U\}_x = [T]_x\{U\}_0 + \{U_e\}_x \quad (4)$$

Notation were used:

- $[T]_x$ - Transfer-Matrix between the left section, the origin section *0,* and the current section $x$;
- $\{U_e\}_x$ - free term vector associate to the current section $x,$ depending to the external loads on the current section $x$;
- $E$ - modulus of longitudinal elasticity (Young modulus);
- $I$ - the moment of inertia.

The general approach with TMM is given in [14]. So, the relations for efforts and deformations can be written in a current section $x$, as (5):

$$\begin{cases} v(x) = v_0 + x\omega_0 - \frac{x^3}{6EI}T_0 + \\ +\frac{x^2}{2EI}M_0 - \frac{F}{6EI}(x-a)^3 - \\ -\frac{F}{6EI}(x-3a)^3 - \frac{F}{6EI}(x-5a)^3 \\ \omega(x) = \omega_0 - \frac{x^2}{2EI}T_0 + \\ +\frac{x}{EI}M_0 - \frac{F}{2EI}(x-a)^2 - \\ -\frac{F}{2EI}(x-3a)^2 - \frac{F}{2EI}(x-5a)^2 \\ T(x) = T_0 + F + F + F \\ M(x) = T_0 x + M_0 - F(x-a) - \\ -F(x-3a) - F(x-5l) \end{cases} \quad (5)$$

With (5), relation (4) can be written as a matrix relation (6):

$$\begin{Bmatrix} v(x) \\ \omega(x) \\ T(x) \\ M(x) \end{Bmatrix} = \begin{bmatrix} 1 & x & -\frac{x^3}{6EI} & \frac{x^2}{2EI} \\ 0 & 1 & -\frac{x^2}{2EI} & \frac{x}{EI} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -x & 1 \end{bmatrix} \begin{Bmatrix} v_0 \\ \omega_0 \\ T_0 \\ M_0 \end{Bmatrix} + \\ + \begin{Bmatrix} -\frac{F}{6EI}[(x-a)^3 + (x-3a)^3 + (x-5a)^3] \\ -\frac{F}{2EI}[(x-a)^2 + (x-3a)^2 + (x-5a)^2] \\ +F+F+F \\ -F[(x-a)+(x-3a)+(x-5a)] \end{Bmatrix} \quad (6)$$

At the right end of the beam, it can be written in relation (6) $x=6a$, and it can be obtained (7):

$$\begin{Bmatrix} v(6a) \\ \omega(6a) \\ T(6a) \\ M(6a) \end{Bmatrix} = \begin{bmatrix} 1 & 6a & -\frac{(6a)^3}{6EI} & \frac{(6a)^2}{2EI} \\ 0 & 1 & -\frac{(6a)^2}{2EI} & \frac{6a}{EI} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 6a & 1 \end{bmatrix} \begin{Bmatrix} v_0 \\ \omega_0 \\ T_0 \\ M_0 \end{Bmatrix} + \\ + \begin{Bmatrix} -\frac{F}{6EI}[(5a)^3 + (3a)^3 + (a)^3] \\ -\frac{F}{2EI}[(5a)^2 + (3a)^2 + (a)^2] \\ +3F \\ -F[(5a)+(3a)+(a)] \end{Bmatrix} \quad (7)$$

or, (8):

$$\begin{Bmatrix} v(6a) \\ \omega(6a) \\ T(6a) \\ M(6a) \end{Bmatrix} = \begin{bmatrix} 1 & 6a & -\frac{36a^3}{EI} & \frac{18a^2}{EI} \\ 0 & 1 & -\frac{18a^2}{2EI} & \frac{6a}{EI} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 6a & 1 \end{bmatrix} \begin{Bmatrix} v_0 \\ \omega_0 \\ T_0 \\ M_0 \end{Bmatrix} + \\ + \begin{Bmatrix} -\frac{125Fa^3}{6EI} - \frac{9Fa^3}{2EI} - \frac{Fa^3}{6EI} \\ -\frac{25Fa^2}{2EI} - \frac{9Fa^2}{2EI} - \frac{Fa^2}{2EI} \\ +3F \\ -9Fa \end{Bmatrix} \quad (8)$$

It can be put on the two embedded ends, in (8), the conditions corresponding on the two embedded supports, as (9) and (10):

- for $x=0$: $\begin{cases} v_0 = 0 \\ \omega_0 = 0 \end{cases}$ (9)
- for $x=6a$: $\begin{cases} v(6a) = 0 \\ \omega(6a) = 0 \end{cases}$ (10)

(9) and (10) are replaced in (8) and it can be obtained (11):

$$\begin{Bmatrix} 0 \\ 0 \\ T(6a) \\ M(6a) \end{Bmatrix} = \begin{bmatrix} 1 & 6a & -\frac{36a^3}{EI} & \frac{18a^2}{EI} \\ 0 & 1 & -\frac{18a^2}{2EI} & \frac{6a}{EI} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 6a & 1 \end{bmatrix} \begin{Bmatrix} 0 \\ 0 \\ T_0 \\ M_0 \end{Bmatrix} + \begin{Bmatrix} -\frac{51Fa^3}{2EI} \\ -\frac{35Fa^2}{2EI} \\ +3F \\ -9Fa \end{Bmatrix} \quad (11)$$

Developing (11), it can be obtained (12):

$$\begin{cases} 0 = -\frac{36a^3}{EI}T_0 + \frac{18a^2}{EI}M_0 - \frac{51Fa^3}{2EI} \\ 0 = -\frac{18a^2}{2EI}T_0 + \frac{6a}{EI}M_0 - \frac{35Fa^2}{2EI} \\ T(6a) = T_0 + 3F \\ M(6a) = 6aT_0 + M_0 - 9Fa \end{cases} \quad (12)$$

with solutions (13):

$$\begin{cases} T_0 = -1{,}5F \\ M_0 = -\frac{19}{12}Fa = -1{,}583Fa \\ T(6a) = 1{,}5Fa \\ M(6a) = -\frac{19}{12}Fa = -1{,}583Fa \end{cases} \quad (13)$$

In this moment, they know all four elements for the origin section, *{U}₀*. With help of matrix relation (6), in which elements $v_0$, $\omega_0$, $T_0$ and $M_0$ are known, it can be calculated, the four elements in any section of the beam, giving for each section, the corresponding value for $x$, thus being able to cover the entire length of the beam. So, it can calculate the stresses and deformations in all beam sections.

As monobloc dental bridge from Fig. 1., has been assimilated with a beam from Fig. 2., it will be possible, all efforts and deformations to calculate in all section of the monobloc dental bridge.

## 4. ANALYTICAL CALCULUS OF STATICALLY INDETERMINATE BEAM WITH CLAPEYRON'S THREE MOMENTS EQUATION

Analytical calculus for a statically indeterminate beam can be made with Clapeyron's three moments equation, after [29] and [36].

It is considered the double static indeterminate beam as in Fig. 3., the same beam from Fig. 2., to which it will be applied twice the Clapeyron's three moments equation.

For this beam, it must be written the three moments Clapeyron's equation twice, as (14):

$$\begin{cases} M_0 l_0 + 2M_1(l_0 + l_1) + M_2 l_1 + 6\left(\frac{S_{01_s}}{l_0} + \frac{S_{21_s}}{l_1}\right) = 0 \\ M_1 l_1 + 2M_2(l_1 + l_2) + M_{3'} l_2 + 6\left(\frac{S_{12_s}}{l_1} + \frac{S_{3'2_s}}{l_2}\right) = 0 \end{cases} \quad (14)$$

We have the conditions (15) for the system (14):

$$\begin{cases} l_0 = 0 \\ l_2 = 0 \\ S_{01_s} = 0 \\ S_{3'2_s} = 0 \end{cases} \quad (15)$$

System (14), with (15) becomes (16):

$$\begin{cases} 2M_1 l_1 + M_2 l_1 + 6\frac{S_{21_s}}{l_1} = 0 \\ M_1 l_1 + 2M_2 l_1 + 6\frac{S_{12_s}}{l_1} = 0 \end{cases} \quad (16)$$

The maximum bending moments for the statically determinate beam *1-2* are the following, (17):

$$M_3 = M_5 = \frac{5}{6}Fa \quad (17)$$

and (18):

$$M_4 = \frac{3}{2}Fa \quad (18)$$

and the static moments are given by relation (19):

$$S_{21_s} = \frac{57}{2}Fa^3 = S_{12_s} \quad (19)$$

So, the system (16) with $l_1=6a$ becomes (20):

$$\begin{cases} 12M_1 + 6M_2 = -\frac{57}{2}Fa \\ 6M_1 + 12M_2 = -\frac{57}{2}Fa \end{cases} \quad (20)$$

with solutions (21):

$$\begin{cases} M_1 = -\frac{19}{12}Fa = -1{,}583Fa \\ M_2 = -\frac{19}{12}Fa = -1{,}583Fa \end{cases} \quad (21)$$

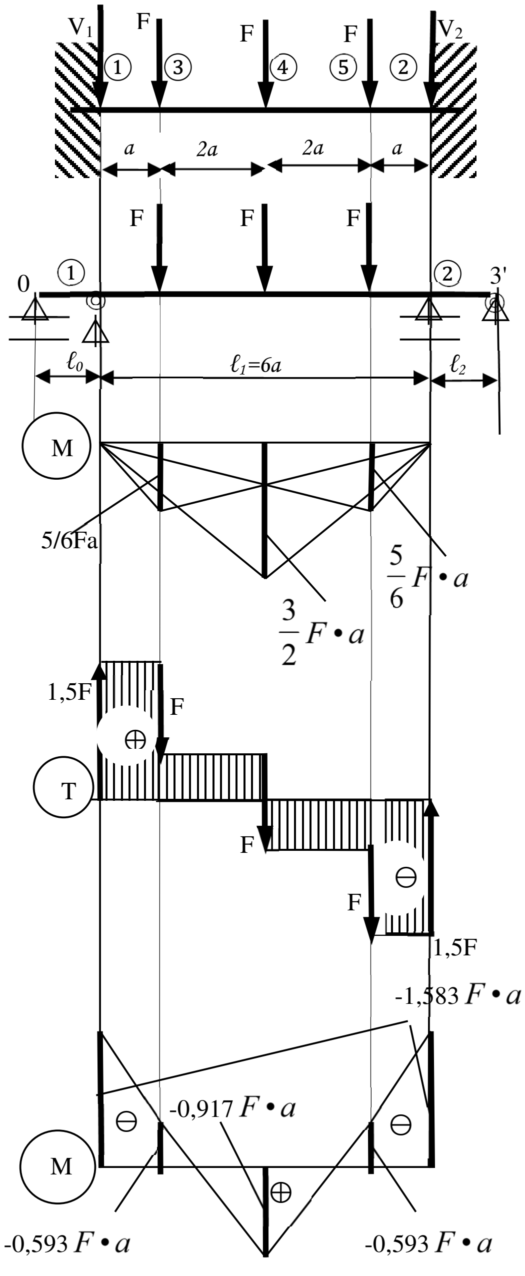


**Fig. 3. The static indeterminate beam studied with Clapeyron's equation of three moments**

Now, we can calculate the vertical reactions from the two embedded supports, which, due to the symmetry, are equal and have the value (22):

$$V_1 = V_2 = -1{,}5F \tag{22}$$

thus, verifying the projection equation of all forces in the vertical direction.

So, the two efforts diagrams can be drawn for the cutting forces $T$ and for the bending moments $M$, obtaining the same values as those obtained with *TMM*, as in Fig. 3.

The maximum cutting forces are at boundaries and the maximum moments are at boundaries too.

## 5. CONCLUSIONS

This work is a continuation of the research and calculus for a monobloc dental bridge, with two poles at the two ends of the bridge and with two edentulous (missing teeth, gaps) between the two poles. This bridge was assimilated with a beam that was considered to be embedded at the level of the two poles and with aggregation elements corresponding to the missing teeth, between the two poles.

Calculus of this dental bridge was done by TMM, and results validation was done by solving the problem to applying the Clapeyron's three moments equation.

This paper proposes an interesting approach to calculus for a monobloc dental bridge with two poles and two edentulous between the poles assimilated as a statically indeterminate beam, at two ends embedded and with three vertical forces, by TMM. This method can be programming easily, rapidly to obtain results. In the future, experimental results will also be presented, which are hoped to validate the theoretical results obtained in this work through TMM and through the classical calculus with Clapeyron's three-moment equation.

## 6. REFERENCES


[1] Bumbu, B. A., Bumbu, G. A., Berechet, M.-C., Rus, V., Ruxanda, F., Miclaus, V., Vicas, R. M., Rotaru, D. I., Zdrinca, C. F., Ciobanu, M. M., Berechet, D., *Osseointegration of zirconium dental implants three months after insertion in rabbit femur. Histopathological study*, Rom J Morphol Embryol, 59(3):781–786, 2018.

[2] Burke, F. J. T., Lucarotti, P. S. K., *Ten year survival of bridges placed in the General Dental Services in England and Wales*, Journal of Dentistry, vol. 40, Issue 11, https://doi.org/10.1016/j.jdent.2012.07.002, 2012.

[3] Chisnoiu, A. M., Rotaru, D. I., Radu Marcel Chisnoiu, R. M., *Essential guide to oral pathology,* Editura Medicală Universitară "Iuliu Haţieganu", 2022.

[4] Chisnoiu, A. M., Moldovan, M., Sarosi, C., Chisnoiu, R. M., Rotaru, D. I., Delean, A. G., Pastrav, O., Muntean, A., Petean, I., Tudoran, L. B., Pastrav, M., *Marginal Adaptation Assessment for Two Composite Layering Techniques Using Dye Penetration, AFM, SEM and FTIR: An In-Vitro Comparative Study*, Appl. Sci., 11*(12),* 5657; https://doi.org/10.3390/app11125657, 2021.

[5] Chisnoiu, R., Moldovan, M., Chisnoiu, A., Hrab, D., Rotaru, D., Păstrav, O., Delean, A., *Comparative apical sealing evaluation of two bioceramic endodontic sealers*, Med Pharm Rep., 2019, Dec; 92 (Suppl No 3): S55–S60, Published online 2019 Dec 15. doi: 10.15386/mpr-1516, 2019.

[6] Chisnoiu, R. M., Delean, A. G., Muntean, A., Rotaru, D. I., Chisnoiu, A. M., Cimpean, S. I., *Oral Health-Related Knowledge, Attitude and Practice among Patients in Rural Areas around Cluj-Napoca, Romania,* Int. J. Environ. Res. Public Health *2022,* 19*(11), 6887;* https://doi.org/10.3390/ijerph19116887, 2022.

[7] Chisnoiu, R. M., Moldovan, M., Prodan, D., Chisnoiu, A. M., Hrab, D., Delean, A. G., Muntean, A., Rotaru, D. I., Pastrav, O., Pastrav, M., *In-Vitro Comparative Adhesion Evaluation of Bioceramic and Dual-Cure Resin Endodontic Sealers Using SEM, AFM, Push-Out and FTIR*, Appl. Sci. 2021, *11*(10), 4454; https://doi.org/10.3390/app11104454, 2021.

[8] Codrea, L., Tripa, M.-S., Opruţa, D., Gyorbiro, R., Suciu, M., *Transfer-Matrix Method for Calculus of Long Cylinder Tube with Industrial Applications,* Mathematics *2023,* 11*(17),* 3756; https://doi.org/10.3390/math11173756, 2023.

[9] Codrea, L., Tripa, M.-S., Opruţa, D., Suciu, M., *Studies about the bending behavior of a new sandwich composite material with COREMAT heart*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics and Engineering, Vol. 66, No. 2, pp. 249-254, 2023.

[10] Codrea, L., Tripa, M.-S., Opruţa, D., Suciu, M., *About bending tests for two composite materials: Fabric MAT 300 and COREMAT*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics and Engineering, Vol. 66, No. 2, pp. 241-248, 2023.

[11] Dikova, T., Vasilev, T., *Bending fracture of Co-Cr dental bridges, produced by additive technologies: Simulation analysis and test*, Engineering Fracture Mechanics 218/2019, https://doi.org/10.1016/j.engfracmech.2019.106583, 2019.

[12] Dikova, T., *Bending fracture of Co-Cr dental bridges, produced by additive technologies: experimental investigation,* Procedia Structural Integrity 13 (2018), 461-468, Elsevier B.V. Peer-review under responsibility of the ECF22 organizers, 10.1016/j.prostr.2018.12.077, 2018.

[13] Gaspar, M., Weichert, F., *Integrated construction and simulation of tool paths for milling dental crowns and bridges*, Computer-Aided Design 45/2013, 1170–1181, 2013.

[14] Gery, P.-M., Calgaro, J.-A., *Les Matrices-Transfert dans le calcul des structures*, Editions Eyrolles, Paris, 1973.

[15] Kui, A., Chisnoiu, A. M., Rotaru, D. I., Zaharia, A., *PROTHÈSES FIXÉES UNIDENTAIRES. Notions pratiques pour les préparations dentaires*, Editura Medicală Universitară "Iuliu Haţieganu", 2022.

[16] Opruta, D., Tripa, M., Codrea, L., Rosu, D., Teodorescu-Draghicescu, H., Suciu, M., *About experimental research of tensil loaded composite materials used in automative industry*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics and Engineering, Vol. 65, No. 3, 2022.

[17] Quinna, G. D., Studart, A. R., C. Hebert, C., VerHoef, J. R., Arola, D., *Fatigue of zirconia and dental bridge geometry: Design implications*, Dental Materials 26/2010, 1133–1136, doi: 10.1016/j.dental.2010.07.014, 2010.

[18] Rotaru, D. I., Delean, A. G., *Guide to the diagnosis and treatment of conditions in the field of oral pathology*, Editura Medicală Universitară "Iuliu Haţieganu", 2015.

[19] Rotaru, D., Chisnoiu, R., Chisnoiu, A., *Coronary reconstructions*, Editura Medicală Universitară "Iuliu Haţieganu", 2019.

[20] Rotaru, D. I., Berechet, D., Scrobotă, I., Moca, A., Matei, R. I., Dima, R., *Enameloplasty in interdisciplinary treatment of dental injuries – case report,* Medicine in Evolution, 2022/12, Vol. 28, Issue 4, p. 6, 2022.

[21] Studart, A. R., Filser, F., Kocher, P., Gauckler, L. J., *Fatigue of zirconia under cyclic loading in water and its implications for the design of dental bridges*, Dental Materials, 23/2007,106–114, doi: 10.1016/j.dental.2005.12.008, 2007.

[22] Suciu, M., *About an approach by Transfer-Matrix Method (TMM) for mandible body bone calculus*, Mathematics, *11*(2), 450, https://doi.org/10.3390/math11173756, 2023.

[23] Suciu, M., 2013, *About Buckling Bio-Composite Sandwich Bars,* Applied Mechanics and Materials, Vol. 245, pp. 39-44, Editor Trans Tech Publications Ltd, 2013.

[24] Suciu, M., *About the Study of Bending Beam on Elastic Environment by Transfer-Matrix Method,* Applied Mechanics and Materials, vol. 186, pp.149-155, 2012.

[25] Suciu, M., *An Another Approach for Buckling Calculus of Dental Implant as a Bar on Elastic Environment by Transfer-Matrix Method (TMM*), European Modern Studies Journal, www.journal-ems.com, vol. 6, no. 6, ISSN 2522-9400, pp. 185-198, 2022.

[26] Suciu, M., *About the calculus of cantilever dental bridge with a single pole in medial extension by Transfer-Matrix Method*, European Modern Studies Journal, www.journal-ems.com, vol. 6, no. 6, ISSN 2522-9400, pp. 300-309, 2022.

[27] Suciu, M., *About The Analytical Calculus Of Dental Bridge With Distal Extension And Single Pole Tooth Assimilated As A Beam By Transfer-Matrix Method*, International Journal of Latest Research in Science and Technology, Vol. 6, Issue 6, pp. 19-22, 2020.

[28] Suciu, M., *An Approach Of A Single Dental Bridge As A Frame With Uniform Load By Transfer-Matrix Method*, International Journal of Latest Research in Science and Technology, Vol. 11, Issue 2, 2022.

[29] Suciu, M., Tripa, M.-S., *Strength of Materials,* Ed. UTPress, Cluj-Napoca, Romania, 2021.

[30] Tomescu, M. A., Jäntschi, L., Rotaru, D. I., *Figures of Graph Partitioning by Counting, Sequence and Layer Matrices*, *Mathematics* 2021, *9*(12), 1419; https://doi.org/10.3390/math9121419, 2021.

[31] Tripa, M., Şolea, G., Sorcoi, D., Florescu, I., Sorcoi, A., Păunescu, D., Bâlc, N., Suciu, M., *About buckling calculus of straight bars on elastic environment by Transfer-Matrix Method (TMM) for dental implants*, MATEC Conferences 178, 04007 (2018), IManE&E 2018, https://doi.org/10.1051/matecconf/201817804007, 2018.

[32] Tripa, M., Sorcoi, D., Florescu, I., Sorcoi, L., Paunescu, D., Suciu, M., *Contributions on the analytical calculus of simple dental bridge assimilated with a beam embedded at both ends by Transfer-Matrix Method (TMM),* Acta Technica Napocensis-Series: Applied Mathematics, Mechanics and Engineering, Vol. 62, No. 4, pp. 573-576, 2019.

[33] Tripa, M., Florescu, C., Sorcoi, D., Sorcoi, A., Paunescu, D., Suciu, M., 2020, *About the Study for The Body of Mandible Bone by Transfer-Matrix Method*, Journal of Multidisciplinary Engineering Science and Technology (JMEST) ISSN: 2458-9403 Vol. 7, Issue 12, December-2020, pp. 13233-13237, 2020.

[34] Tripa, M., Sorcoi, D., Florescu, I., Soecoi, L., Paunescu, D., Suciu, M., 2019, *About the study of frames by Transfer-Matrix Method (TMM)-similarity of dental bridges with frames*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics and Engineering, Vol. 62, No. 4, 2019.

[35] Uriciuc, W. A., Vermeşan, H., Botean, A. I., *Research on the surface of the dental alloys with cobalt-crom base*, Acta Technica Napocensis, Series: Applied Mathematics, Mechanics and Engineering, Vol. 62, Issue 3, Oct., 2019.

[36] Warren, C. Y., *ROARC'S-Formulas for Stress& Strain*, 6-ème Edition *McGraw-Hill Book Company,* 1989.

[37] Xuan Lai, Wenjie Si, Danyu Jiang, Ting Sun, Longquan Shao, Bin Deng, *Effects of small-grit grinding and glazing on mechanical behaviors and ageing resistance of a super translucent dental zirconia*, Journal of Dentistry, 66/2017, 23-31, http://dx.doi.org/10.1016/j.jdent.2017.09.003, 2017.

## Calculul unei punţi dentare monobloc cu doi poli şi doi dinţi lipsă ca o grindă prin Metoda Matricelor de Transfer

**Rezumat:** Această lucrare este o continuare a cercetărilor și calculului pentru o punte dentară. Acum, se studiază o punte dentară monobloc, cu doi poli la cele două capete ale punții dentare și cu două edentații între cei doi poli. Această punte dentară monobloc a fost asimilată cu o grindă static nedeterminată, care s-a considerat a fi încastrată la nivelul celor doi poli și cu elemente de agregare corespunzătoare dinților lipsă, între cei doi poli. Calculul pentru această punte dentară monobloc a fost realizat prin Metoda Matricelor de Transfer (MMT), iar validarea rezultatelor s-a făcut prin rezolvarea aceleeași probleme prin aplicarea ecuației celor trei momente a lui Clapeyron. MMT este foarte ușor de programat, pentru a obține rapid rezultate. În viitor, vor fi prezentate și rezultate experimentale, care se speră să valideze rezultatele teoretice obținute în această lucrare prin MMT și prin calculul clasic, cu ecuația celor trei momente a lui Clapeyron.

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