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STUDY UPON THE VIRTUAL RESTORATION METHODS FOR THE PAINTINGS ON A WOODEN SUPPORT

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Abstract

The paper refers to the improvement of a classical wood painting or wood icon-restoration method. Over time, deformations and cracks appear on the painted surface. The restoration and conservation refer to the various treatments aimed at stabilizing the surface and, eventually, the straightening of the painted layer. In this paper, I submit a non-destructive evaluation of the surface deformations, and the calculation of the correction parameters for several virtual-restoration options, to analyze and decide the optimal restoration method.

Key words: *parameters; wooden wedge; restoration.*

INTRODUCTION

Old paintings or icons undergo over time, painted panel deformations especially because of the contraction and swelling phenomena, which are caused by the variations in humidity and by the seasonal climate variations.

The straightening deformations are mostly noticed in the paintings on large surfaces, whose dimensions are of 2-3 meters, or even more, on the ones placed in palaces, cathedrals or museums with tradition in keeping the works of art in their patrimony. Even those that now can be kept in a controlled environment throughout the year, they were formerly kept in improper conditions, which could have affected their wooden support and surface.

They may be placed in cassettes and modulated, in order to prevent the deformations; and they have, on the backside, a rigid reinforcing structure, made of stiffened frames, with the role of supporting the painted panel and assume the hanging process effort. The reinforcing structure also has the role of maintaining the painting support in a firmly assembled state, in order to prevent the possible shifts, cracks or deformations that might affect the condition of the painting. By the dimensional variations, owed to the annual normal climatic conditions, tensions arise between the support structure of the painting and the wooden panels constituting the surface of the painting.

On the painted layer, along the elements, at their joints, cracks and splits appear on the paintwork; whereas, on the painted surface, panel deformations appear, shaped as concavities and convexities.

In the following, these phenomena will be studied, for the purposes of a rapid intervention aimed at fixing the surface, by methods specific to either concavity or convexity treating.

Convexities are the most frequent and pronounced. In the study focused on them, solutions will be searched, in view of a rapid remedying intervention. A theoretical study is initiated, which underlies the creation of a calculation software or of formulas meant to optimize and prepare the intervention aimed at fixing the deformation from straightening. The study also considers the specific parameters of the wooden support, such as panel thickness, radii of curvature, width of a support element, dimensions and parameters of the wooden wedges to be used in fixing the smoothness flaws. A study of the parameters afferent to the wooden wedges to be used in the restoration is also submitted, in terms of central angle, length of the wooden wedge, radius of the concavity or convexity arching.

STUDY ON THE PAINTED PANEL DEFORMATIONS

This study sets out to analyze the straightening correction-modality of the deformations within the wooden support structure of the old paintings. Concavities or convexities appear at the level of a wood piece, which will be corrected by different, specific methods, depending on the form of the deformations. In this way, the procedure involves performing a small notch, in the case of the convexities, and introducing a wooden wedge; on the other hand, it involves, in the case of the concavities, notching and removing some “V”-shaped material from the support and sticking, either directly, or with addition of material, a straight wedge or a veneer. The wedges should be ideally executed from the same wood species, dating back in a time period similar to the date of the painting.

In the case of the convexity-shaped deformations, “V”-shaped glued narrow wedges will be introduced in the notched areas and, after the stabilization of the wooden panel, the surplus will be removed from the wedges, as against the inner surface of the painting. The maximal thickness of the wedge will compensate the difference between the wooden lamella length and, respectively, the circular arc length and central arc cord, achieving thereby the dimensional stabilization of these geometrical elements, as well as a smooth painting surface.

A simulation can be achieved, depending on the notch penetration depth in the painting support, on the angle of the wedge and on the opening of the wedge.

There will be determined, by nondestructive methods, with laser sensors, the maximal distance that the current deformation of straightening, with concavity or convexity appears at, as well as the maximal arrow, positive or negative, of the deformation. Based on these data, the specific parameters of the profile geometry will be calculated, namely the height or the depth of the arrow, the central curvature radius, the arc length, the cord length, the central angle of the deformation. The thickness of the wooden support need be specified, as well as the permitted notching depth, so as not to affect the painting surface or the quality of the art object. The notch depth is ideally 1/2 or at most 2/3 of the panel thickness.

In general, there is recommended to notch and place the wedge in the middle of the arc and, by the wedge thickness at its contact with the inner surface of the panel, the differences between the undulation arc length and the cord length, respectively the new smoothed length of the panel lamella surface will be balanced.

In special cases, when the width of the wooden piece is great and the curvature becomes pronounced, two notches can be performed in symmetrical areas, by splitting the arc into three equal parts, with a view not to forcing the rectification of the panel surface, by a single wedge with too great an aperture angle (central angle).

The calculation formulas are presented as follows; and, on their basis, a calculation software with several variables has been achieved, whereby different situations and variants can be simulated, with a view to solving the undulations of the old paintings or icons placed on wooden support.

Based on the complex calculation formulas, one can simulate solving situations with one or two rows of wedges, on a wooden piece, with notch penetration depth in the material, at 1/2 or 2/3 of the thickness, with variable wedge central angle.

The form afferent to the curvature of the painting surface can be determined with the classical methods (UNESCO 1955), in restoration laboratories, by the placement on a smooth surface, with the painted face upwards. Lasers can be used, instead of comparators In order to determine the topometric shape of the painting surface, a 3D-scanning can be made, which much facilitates its study and virtual modeling.

In certain cases, for the paintings on wooden support, the thickness and variation were determined for the wooden pieces in the composition of the painting support, as they can influence the deformations (undulations) of the painting surface. This aspect was studied by means of a comparator with magnetic plate, placed on the opposite side of the painting (Bidacca 2009). Under the current conditions, the painting can be placed in a rigid frame and by 3D-scanning of both sides, the painting sides can be virtually restored; the realistic and dimensional geometrical representation afferent to the wooden support of the painting is obtained by 3D modeling. In this way, the variation in thickness of the wooden support, in any point, can be known. As we have the virtual model of the wooden support, of high accuracy in terms of dimension and shape, we can proceed much more efficiently to straightening the painting surface.

The calculations can be made, on the basis of the following calculation formulas, for the arc length, L (1), the length of the cord corresponding to the arc, Lc (3) and the arc height, h (2), which is the maximal distance between the cord and the circular arc:

$$L = \frac{\pi r \delta}{180} = 0.017453\ r\ \delta \approx \sqrt{Lc^2 + \frac{16}{3}h^2} \quad (1)$$

$$h = r\left(1-\cos\frac{\delta}{2}\right) = \frac{Lc}{2}\operatorname{tg}\frac{\delta}{4} = 2r\sin^2\frac{\delta}{4} \quad (2)$$

$$Lc = 2r \sin \delta \quad (3)$$

where: r is the radius of the circle that the arc pertains to, and δ is the central angle for the arc of the local convexity of the panel. The support of these variables is shown in Fig. 1.

Based on the calculation formulas, one can make various types of software, in a chosen programming language, meant to determine the parameters and the number of the wedges necessary for straightening the painting surface. For the purposes of rapid testing, the calculation formulas can

be also put in a calculation sheet, within an excel register, in order to simulate the shape of the wedge and the depth of introduction in the wooden support of the painting. By the use of the calculation tools and the Goal Seek analysis or the Data Table of a two-variable function, the form and geometrical characteristics of the wedges necessary for straightening the wooden support of the painting, can be obtained.

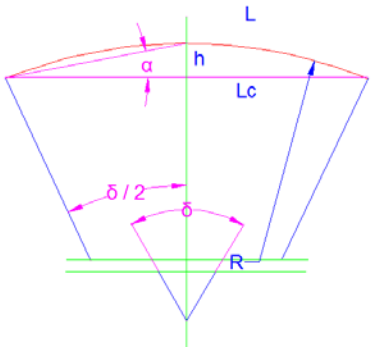

Fig. 1.
Convex deformation parameters of painting panel

With a view to simulating the 3D-modelling mode of the current situation and of the form obtained after the restoration, a simulation in SolidWorks was achieved and launched in execution, by means of a macro-command, in an interface API VBA.

DIMENSIONAL CALCULATION OF THE WEDGE AND OF THE WEDGE CHANNEL

The case of the convexity-shaped undulations of the painting surface, which are also the commonest, is taken into consideration. For the situation with concavity-shaped undulations, the calculations are similar; yet "V"-shaped notches will be practiced by sawing, milling or chiseling and the borders will be glued by means of an adhesive, either directly or with a technical veneer, of controlled thickness, between the panel borders.

In the situation of the convex undulations, when we already have determined the form elements presented above, respectively the arc length, the cord length, the arc height and the central angle for the arc of the panel convexity, we will make an intervention by notching and introducing therein a triangular-section wedge. By the introduction of the wedge, we will compensate the difference between the arc length and the length of the cord comprised in the arc. The result will consist in straightening the wooden support of the painting. The semi-cord traced from a point of the arc, to the maximum of the arc, will form an angle with the cord of the main arc, noted α, and will rest on the height h a of the arc. Given that this angle can be easily determined from the construction obtained in figure 1, one can see that this angle, which is an angle on circle, is half the angle comprised between the symmetry axis of the arc and one side of the angle resting the arc; hence it is four times smaller than the angle δ.

In Table 1, one can see the measured and calculated values for these parameters, in a simulated situation.

Table 1

Convex deformation parameters of painting panel

The arc length	**L**	mm				251.065	
The central angle for the arc	***δ***	rad			0.31932		
		degrees			18.2956		
The radius	**r**	mm			786.25		
The cord length	**Lc**	mm	250				
The arc height	**h**	mm	10				
The difference arc-cord	**D**	mm					1.06531
The circle angle	***α***	rad		0.0798			
		degrees		4.5739			

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In Fig. 2, there are highlighted the precedence relations, obtained by auditing the chained calculation formulas, for determining the difference between the length of the arc and of the cord, D.

The arc length	**L**	mm				251.065	
The central angle for the arc	***δ***	rad			0.31932		
		degrees			18.2957		
The radius	**r**	mm			786.25		
The cord length	**Lc**	mm	250				
The arc height	**h**	mm	10				
The difference arc-cord	**D**	mm					1.0653
The circle angle	***α***	rad		0.07983			
		degrees		4.57392			

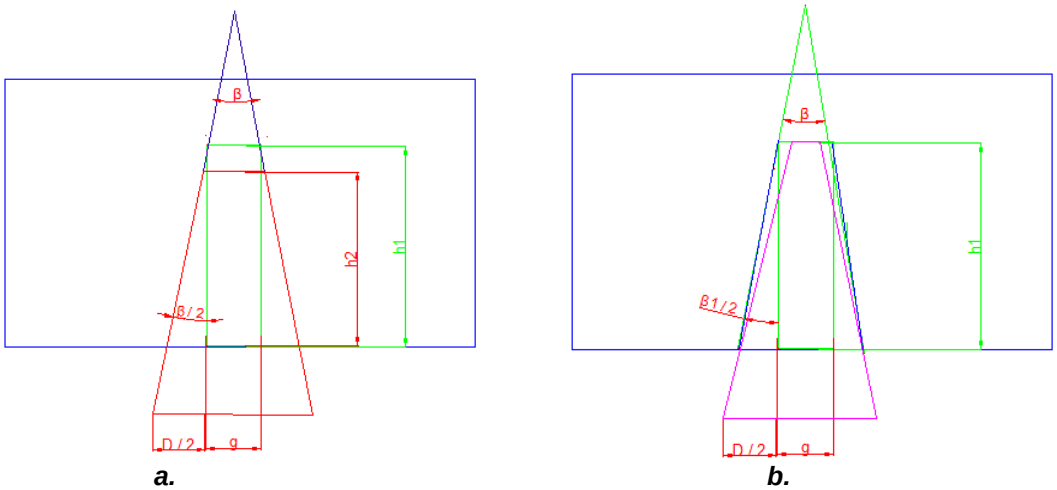
Fig. 2.
The relationships between cells and formulas with tracer arrows in the Formula Auditing group with Trace Precedents commands

By the introduction of the triangular wedge in the lower part of the wooden support, the cord will superpose (on) the arc and will have the same length. The difference between the arc length and the cord length is noted D and must be compensated by the width of the triangular wedge on the level of the lower part of the wooden support of the painting.

In order to introduce the wedge in the material, a notch will be performed, a channel along the support. The channel can be achieved by a slight sawing, with a narrow circular saw blade (Fuente 2009, Fuente 2009, Timar 2003). The parameters of the wedge channel must be well calculated, with a view to straightening the painting surface, under optimal conditions.

In order to exemplify the following calculation relations, necessary for determining the parameters afferent to the wedge and wedge channel, the detail with the wedge channel and the triangular wedge is submitted in Fig. 3.a.

These parameters are for the wedge channel, respectively, the wedge-channel depth h1 and wedge-channel thickness (width) g, as well as the specific parameters to the triangular wedge, respectively the apical angle of the wedge β, the wedge penetration depth in the wedge channel h2, the beveling of the wedge t and the recalculated apical angle β1.



a. ***b.***

Fig. 3.
Channel parameters up and wedge; a. Case 1 : t > g; b. Case 2 : t < g.

The thickness of the wedge channel is technologically settled, by the choice of an adequate saw blade; and the depth of the channel will by adjusted, at the portable swing circular-saw, by means of the adjusting and guiding devices. In order to avoid further tensions between the wedge and the wooden support of the painting, the wedge peak will be beveled, lest it might press at the bottom of the wedge channel and produce creaks. Two calculation situations, shown in Fig. 3a and b, are presented.

The former case refers to the situation in which the wedge beveling t is greater than the wedge-channel thickness g and, in this case, in order to obtain the straightening, the wedge is not completely introduced in the channel, only to a calculated depth of penetration h2, which will be marked (traced) on the wedge, will be pressed only to the marking and will be maintained pressed until the hardening of the adhesive. This case is exemplified in Table 2, with finalizing the calculation of the penetration depth afferent to the wedge h2; and with tracing the auditing precedents, necessary for this calculation.

Table 2

The parameters of wedge and channel up (case 1 : t>g)

The difference arc-cord	D	mm	1.06531					
The thickness of the wedge channel	h1	mm		8				
The wedge-channel thickness	g	mm			2			
The angle of wedge channel	β	rad				0.133		
		degrees				7.6184		
The wedge beveling	t	mm			2.4			
The recalculated thickness of wedge	h2	mm					4.9962	4.9962

The latter case refers to the situation in which the wedge beveling t is smaller than the wedge-channel thickness g and, in this case, the angle β1 will be recalculated – angle of the wedge channel, after the wedge pressing in the channel, as one can see from the Fig. 3b and from the Table 3, where the auditing precedents for the recalculation relation β1 are further submitted.

Table 3

The parameters of wedge and channel up (case 2 : t>g)

The difference arc-cord	D	mm	1.065305					
The thickness of the wedge channel	h1	mm		8				
The wedge-channel thickness	g	mm			2			
The angle of wedge channel	β	rad					0.132967	
		degrees					7.618441	
The wedge beveling	t	mm				1.8		
The recalculated angle of wedge channel	$\beta 1$	rad						0.157834653
		degrees						9.0433

It is recommendable that the wedge beveling and the thickness of the wedge channel should be as close in value as possible, for the wedge to be well set on the panel, by the adhesive, and for the desired straightening of the painting, on the wooden support, to be obtained. Likewise, the variant of the case 2 is recommended, where the beveling of the wedge peak should be smaller than the thickness of the wedge channel; yet the wedge angle should be as close as possible to the calculated angle β1.

One can intervene in various parameter-optimization calculations, by means of the complex-analysis object provided by MS EXCEL, Goal Seek (Verschuuren 2013). Such an example is shown in figure 4, when the wedge-channel depth was recalculated, for the simulated angle-increase situation β1 from 9.04326 degrees, to 12 degrees, which led to the channel-depth diminution, up to h1 from 8mm, to 6.01925mm; and, by rounding, 6mm will be taken.

Similarly, one can resort to various parameter-recalculations, with the complex-analysis object in MS EXCEL, tabling a two-variable function. In Fig. 4, a simulation is shown, for the automated calculation of the wedge angle β, depending on the different values taken by the wedge-channel depth h and the wedge-peak beveling t. The table can much extend, so as to comprise all possible situations, function of these variables or others; and the desired calculated value will be obtained at the intersection between the line and the column, which will have the values we desire. Suffice it to modify the values in the end of the line or column, with the particular values we desire; and the table will automatically recalculate the function implemented in the upper left corner of the table.

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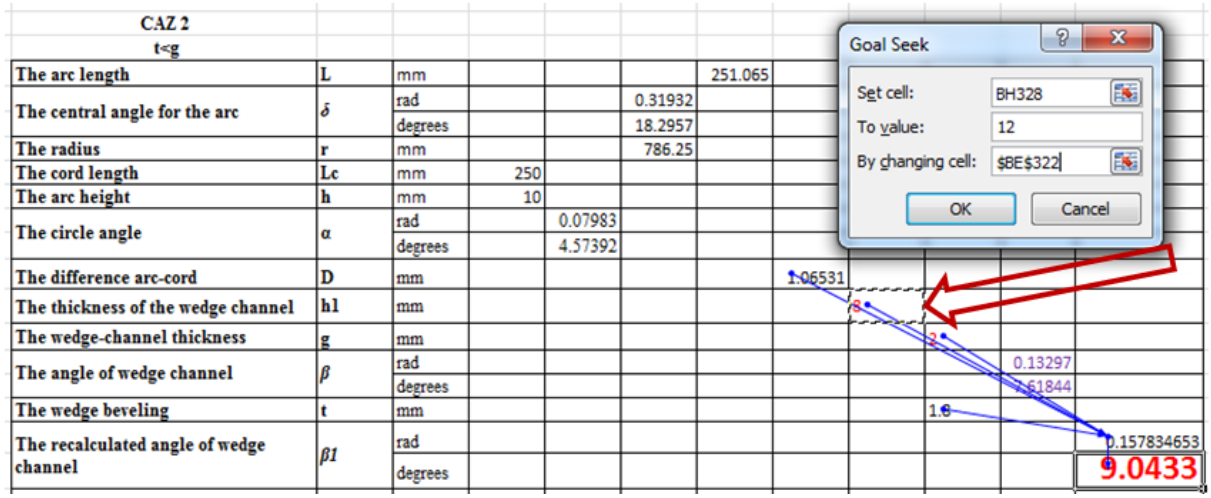
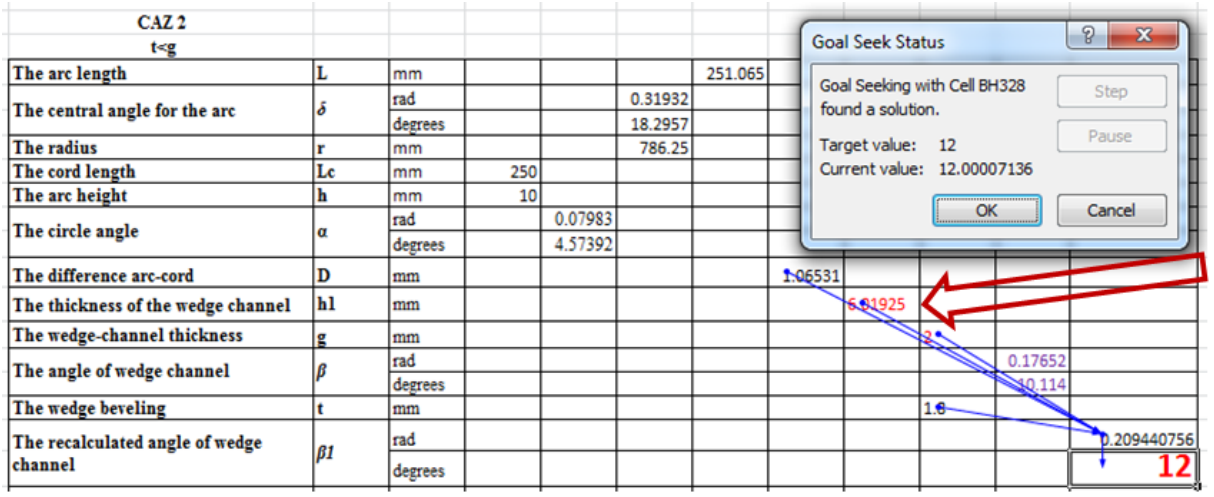


a.



b.

Fig. 4.
Recalculation of thickness channel depending on wedge angle with Goal Seek tool
a. preparation phase; b. recalculation

By simulating situations when one intervenes with wedges whose peak is much more beveled than the notch thickness, negative results are obtained for the wedge penetration depth in the material of the painting support, which means that, at the angle calculated for eliminating the convexity, the wedge should be placed at a small distance from the panel surface, or the panel thickness should be much greater. In order to obviate such situations, it is recommendable, at wedge beveling, to consider the notch thickness, respectively the notch of the cutting blade used when making the notches. The wedge beveling is recommended to be equal or as close as possible to the notch thickness.

After the wedges have been glued and the painted surface has been smoothed, the excess from the wedges is removed and the painting underside is finished. There are several variants of consolidation scaffolds, made both of wood and of metallic elements (aluminum). In the modern restoration variants (Bidacca 2009, Fuente 2009), between the painting on a wooden support and the consolidation scaffold, several support devices with metallic wire, cylindrical or conic arc, as well as gliding paths, meant to allow the wooden support to relieve the inner tensions, by means of small shifts within the frame, in order to compensate the swelling and contraction effects of the support material, due to the environmental climatic fluctuations. These compensating devices are calculated so as to take the entire weight of the painting.

The angle of wedge channel																					
	The wedge beveling																				
7.618	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0
The wedge beveling 5.2	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70	11.70
5.4	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27
5.6	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87	10.87
5.8	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49
6.0	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15
6.2	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82	9.82
6.4	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52
6.6	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23	9.23
6.8	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96
7.0	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70
7.2	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46	8.46
7.4	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23	8.23
7.6	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02	8.02
7.8	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81	7.81
8.0	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62	7.62
8.2	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43	7.43
8.4	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26
8.6	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09	7.09
8.8	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93
9.0	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77	6.77

a.

The recalculated thickness of wedge																					
	The wedge beveling																				
6.4981	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90	4.00
The wedge beveling 4.00	4.75	4.38	4.00	3.62	3.25	2.87	2.50	2.12	1.75	1.37	1.00	0.62	0.25	-0.13	-0.51	-0.88	-1.26	-1.63	-2.01	-2.38	-2.76
4.25	5.05	4.65	4.25	3.85	3.45	3.05	2.65	2.26	1.86	1.46	1.06	0.66	0.26	-0.14	-0.54	-0.94	-1.34	-1.73	-2.13	-2.53	-2.93
4.50	5.34	4.92	4.50	4.08	3.66	3.23	2.81	2.39	1.97	1.54	1.12	0.70	0.28	-0.15	-0.57	-0.99	-1.41	-1.84	-2.26	-2.68	-3.10
4.75	5.64	5.20	4.75	4.30	3.86	3.41	2.97	2.52	2.07	1.63	1.18	0.74	0.29	-0.15	-0.60	-1.05	-1.49	-1.94	-2.38	-2.83	-3.28
5.00	5.94	5.47	5.00	4.53	4.06	3.59	3.12	2.65	2.18	1.71	1.25	0.78	0.31	-0.16	-0.63	-1.10	-1.57	-2.04	-2.51	-2.98	-3.45
5.25	6.24	5.74	5.25	4.76	4.26	3.77	3.28	2.79	2.29	1.80	1.31	0.81	0.32	-0.17	-0.66	-1.16	-1.65	-2.14	-2.64	-3.13	-3.62
5.50	6.53	6.02	5.50	4.98	4.47	3.95	3.43	2.92	2.40	1.89	1.37	0.85	0.34	-0.18	-0.70	-1.21	-1.73	-2.24	-2.76	-3.28	-3.79
5.75	6.83	6.29	5.75	5.21	4.67	4.13	3.59	3.05	2.51	1.97	1.43	0.89	0.35	-0.19	-0.73	-1.27	-1.81	-2.35	-2.89	-3.43	-3.97
6.00	7.13	6.56	6.00	5.44	4.87	4.31	3.75	3.18	2.62	2.06	1.49	0.93	0.37	-0.20	-0.76	-1.32	-1.89	-2.45	-3.01	-3.57	-4.14
6.25	7.42	6.84	6.25	5.66	5.08	4.49	3.90	3.32	2.73	2.14	1.56	0.97	0.38	-0.20	-0.79	-1.38	-1.96	-2.55	-3.14	-3.72	-4.31
6.50	7.72	7.11	6.50	5.89	5.28	4.67	4.06	3.45	2.84	2.23	1.62	1.01	0.40	-0.21	-0.82	-1.43	-2.04	-2.65	-3.26	-3.87	-4.48
6.75	8.02	7.38	6.75	6.12	5.48	4.85	4.22	3.58	2.95	2.31	1.68	1.05	0.41	-0.22	-0.85	-1.49	-2.12	-2.75	-3.39	-4.02	-4.66
7.00	8.31	7.66	7.00	6.34	5.69	5.03	4.37	3.71	3.06	2.40	1.74	1.09	0.43	-0.23	-0.89	-1.54	-2.20	-2.86	-3.51	-4.17	-4.83
7.25	8.61	7.93	7.25	6.57	5.89	5.21	4.53	3.85	3.17	2.49	1.81	1.12	0.44	-0.24	-0.92	-1.60	-2.28	-2.96	-3.64	-4.32	-5.00
7.50	8.91	8.20	7.50	6.80	6.09	5.39	4.68	3.98	3.28	2.57	1.87	1.16	0.46	-0.24	-0.95	-1.65	-2.36	-3.06	-3.76	-4.47	-5.17
7.75	9.20	8.48	7.75	7.02	6.30	5.57	4.84	4.11	3.39	2.66	1.93	1.20	0.48	-0.25	-0.98	-1.71	-2.43	-3.16	-3.89	-4.62	-5.34
8.00	9.50	8.75	8.00	7.25	6.50	5.75	5.00	4.25	3.49	2.74	1.99	1.24	0.49	-0.26	-1.01	-1.76	-2.51	-3.26	-4.02	-4.77	-5.52
8.25	9.80	9.02	8.25	7.48	6.70	5.93	5.15	4.38	3.60	2.83	2.05	1.28	0.51	-0.27	-1.04	-1.82	-2.59	-3.37	-4.14	-4.92	-5.69
8.50	10.10	9.30	8.50	7.70	6.90	6.11	5.31	4.51	3.71	2.91	2.12	1.32	0.52	-0.28	-1.07	-1.87	-2.67	-3.47	-4.27	-5.06	-5.86

b.

Fig. 5.
Recalculation multiple results with a two-variable data table;
a. Recalculation of wedge angle; b. Recalculation of thickness of wedge

CONCLUSIONS

By this work, an attempt is made to optimize and improve the calculations necessary for straightening the big-sized old paintings and icons on a wooden support, which have suffered, over time, surface deterioration, because of the seasonal environmental climatic variations. These surface deteriorations, by convexity and concavity-shaped undulations, can be fixed, by performing notches and introducing triangular-section notches therein, with a view to compensating the differences between their upper and under surface. Given that very valuable and old patrimony objects are, a study was conducted, meant to facilitate the calculation of the geometrical configuration of these wedges. The calculation formulas, as well as the methods of analysis and optimization of these calculations are submitted, so as to efficiently and correctly intervene, with as view to correcting the deformations that have appeared over time.

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