

The Horseshoe Arch in Toledo

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INTRODUCTION

It is now a century since the publication of the famous work “Excursion through the horseshoe arch” by Gómez Moreno (1906). This work established the basis for the interpretation of this key architectural element, which has been crucial in the medieval Spanish architectural history.

As a homage to Moreno’s interesting work, a study has been carried out with students on the History of Construction course in our department. The survey developed includes an analysis of the horseshoe arches still present in Toledo, one of the cities less explored by Gómez in his study. Drawings of 19 easily accessible horseshoe arches, such as the ones found in gates and portals have been made to obtain sufficient data for further conclusions. From the data gathered, the compositional and constructive characteristics of the arch have been studied in order to establish a typological classification according to the principles established by Gómez Moreno (**table 7**).

For the analysis the following geometrical parameters have been considered: the lowering of the arch below the impost line in relation to the radius and the parallelism of the intrados and the extrados. In addition, the existence of wall-embedded work (the constructive solution to join the arch with the lower part of the wall) and the presence of horizontal voussoirs are observed, and their height in relation to the radius of the arch studied. The materials used and the presence of a surround was also noted. After the first survey, the database and the basic parameters were consolidated through site visits, using the existing bibliography (VV.AA.1991), but without making direct drawn surveys. A systematic classification of the horseshoe arches with regard to their location was established: at the exterior gates and portals; in the interior, isolated arches or those that form part of an arcade; in apses, small bows; in transepts, and other possible locations.

Once the data was obtained and analysed, the main characteristics or general criteria of the typical horseshoe arch of Toledo were set, fixing a possible classification for the given examples. Finally, an analysis application procedure was carried out on certain examples, such as the internal arch of Valmardón gate, in an attempt to check the hypotheses of Porres (1988) and Pavón (1988), that this arch was originally a horseshoe arch, having been later modified by offsetting the voussoirs of the springing line. In addition, a comparison of the arches of the Alfonso VI Gate, Bisagra Vieja Gate and the recently discovered Vado Gate was carried out to test the theory of a possible common origin, because of their many compositional and volumetric similarities.

It was not deemed necessary at that point, to establish a chronology of the arches, as Gómez Moreno had done. Indeed, although Toledo had been an important Roman city, and the capital of the Visigoths in Spain, according to the history critics, no surviving building can be dated earlier than the year 1.000 A.D. On the other hand, the Visigoth churches preserved in Spain have a rural character and a small size. Therefore, they might not have many similarities with the churches of the capital, which are known to us only historically. This study, though very interesting, has only been carried out as a constructive and geometrical comparative analysis of the local historic arches, in order to facilitate data for future research.

CIRCULAR HORSESHOE ARCHES IN GATES, PORCHES AND TRANSVERSE ARCHES

To begin with we analysed isolated horseshoe arches of circular directrix. These arches can be found on both the external gates of the fortified walls or in building porches, and inside, in courtyards and transverse arches of churches. Sixteen cases have been identified and studied in wall gates, nine in building porches and five in interior arches.

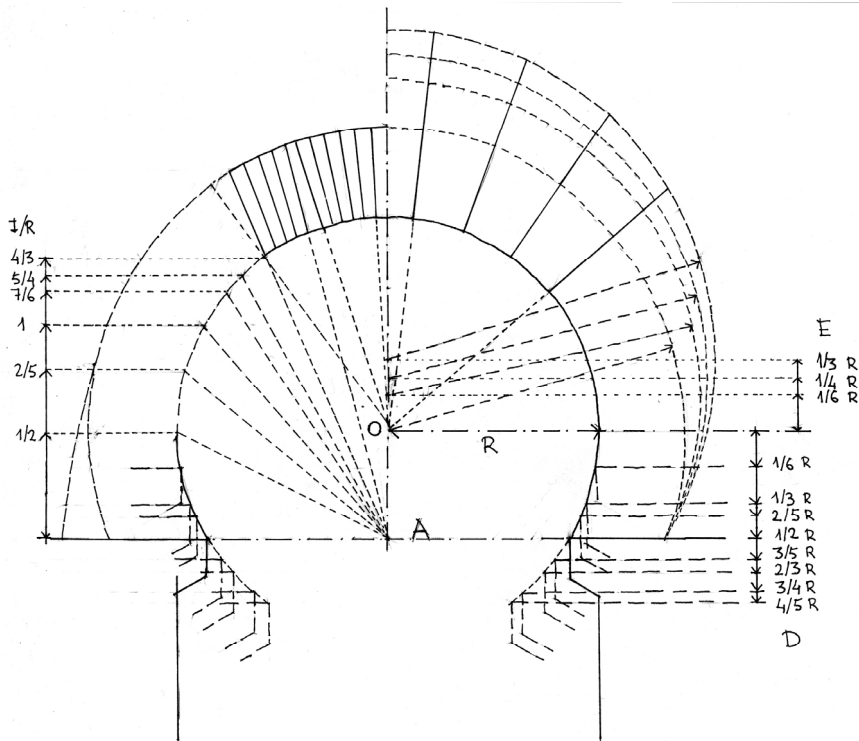


Figure 1. Geometrical parameters and layout of the horseshoe arch.

In **table 1**, following the listing established in **figure 1**, the characteristics of those arches are shown. These characteristics include: geometrical characteristics, such as the relation between the lowering of the arch below the semi-circumference D , in relation to the radius R ; the centre displacement from the lay-out by the extrados E regarding the radius; and the height of the wall-arch horizontally embedded work (*enjarje* in Spanish) from the springing line of the arch I , in relation to the radius R . In this last case, the horizontality of the lower voussoirs in relation to the radius I/R has been included even though it is not technically the same, since in this case, it is the constructive solution used in the area of the arch where the horizontal voussoirs are laid-out from the centre of the arch. Data about the centre of radiation for the voussoirs are included. This can be achieved from the centre of the arch O , or from the centre of the impost line at the horizontal springing line A .

Other geometrical characteristics of the arches have been observed, although they are not included in table 1. For example, the lowering of the extrados inclined outwards does not appear in any of the examples studied in Toledo. Likely, the existence or lack of key voussoirs has not been established, since it is difficult to state it precisely in the brick masonry, and it is also complex in the stone masonry because the voussoirs are not regular in most cases. The relation between the opening of the jambs and the diameter of the horseshoe arch - which coincides in most cases - has not been indicated either.

The materials used are specified in the next section, whether it was brick, limestone or rendering. In the latter, where possible, also the material used for rendering is stated. In some occasions, the jambs are of stone and the arches of brick. In such cases, the material of the arch is specified. Finally, other characteristics complete the description: as for example the presence of *opus africanus* at the jamb (vertical ashlar stones alternated with short horizontal ones as in the characteristic typology of the gates of the Toledo fortified walls of Toledo (Villanueva 2004)). A reference is included to the presence of a surround and upper interlacing arches, as well as whether the arch has suffered any major restoration which could have altered the original geometrical composition. The anomalies found are indicated in the notes on **table 1**. When no reliable facts have been found, rejecting the data has been decided.

Data analysis of the city wall gates

On the Toledo rampant gates the lowering of the circular horseshoe arch is quite variable, oscillating in between $1/6$ and $1/3$ of the radius. Without considering the values of the three restored arches of the Alcántara gate, the other 13 gates are shown in **table 3**. The displacement of the extrados in relation to the intrados can only be seen in the rear arch of the Sol gate. There are doubts of the existence of it in the external arch of the Vado gate. The existence of the constructive solution of the wall embedded work and its height varies greatly. There is no use of this constructive solution in five of the cases; in three of them, with radial layout from the centre of the

arch, there are horizontal voussoirs at the springing course. The wall embedded work constructive solution appears in eight cases, with different heights, as shown in **table 5**.

In most cases, except in the tower of San Martín Bridge and in the internal arch of Alfonso VI Gate, the voussoirs radiate from the centre at the springing line of the arch. In relation to the material used, seven arches are made of brick and nine of granite. Interestingly, all the arches from exterior gates of the outside wall are made of stone, corresponding to the fortified character of the wall. This material is, though, not frequent in other occasions.

Data analysis of building porches

The geometrical data of the arches in building porches are similar to those analysed in the walls. Indeed, the lowering of the arch is also variable. Displacement of the extrados is shown only in two occasions, and the wall-embedded work constructive solution appears in three of the eight cases studied. These analyses are shown on tables 3, 4 and 5, in correlation to the analysis of the group of horseshoe arches with circular directrix.

Regarding the material, face brickwork is used in all the cases studied, except in the remains of the entrance arch in the church of Santa Justa, where stone – either marble or limestone - is used. A high percentage of these gates show a surround, and more than half of them have interlacing arches in the upper part. A great number of these horseshoe arches have been restored in the second half of the twentieth century, and possibly, the original characteristics could have been modified. It is, therefore, quite difficult to know what they were originally.

Analysis of the internal arches

The transverse arches studied have been restored and this makes the data not very reliable. The double arch of Santa Clara convent is inscribed in a surround decorated with plaster arabesques. Its intrados is rendered in white, preventing the study of the brickwork that is probably at the base. Finally, the arch in Bulas Street is rendered shaping some geometric characteristics not frequent in Toledo, with the extrados displaced. Nevertheless, the value of the lowering has been determined in all cases, and the lowering of the arch below the level of the corresponding circumference has been compiled in the analysis shown in **table 3**.

HORSESHOE ARCHES IN ARCADES BETWEEN AISLES AND CLOISTERS

Table 2 indicates the data obtained from the comparative study of ten arcades. These arcades are located in between the aisles and the cloister, at both sides, in the Santa Clara Convent.

In three cases, (San Lucas, San Sebastián and Santa Eulalia) they are churches from the Visigoth period, which maintained the Catholic worship (*Mozarabic*) during the Muslim domination, and continued to be churches of Mozarabic rite after the Re-conquest. Nevertheless, some historians

think that San Sebastián could have been a mosque in Arabic times. Another three (San Román, San Andrés and San Vicente) are thought to be constructed as churches for the Latin rites after the Re-conquest. Two (El Cristo de la Luz and El Salvador) were originally mosques and were transformed into churches after the Reconquest. Some critics claim that El Cristo de la Luz could have been a church prior to a mosque. In one case (Tornerías) it is a mosque constructed already in the Christian period, that is Mudejar in style. Finally Santa María la Blanca was a synagogue built in Christian times and later transformed into a church.

Seven of the buildings have a basilica plan with three aisles and arcades separating the main aisle from the lateral ones. Among other characteristics, they constitute a singular type of medieval architecture in Toledo due to the use of the horseshoe arches, though unfortunately poorly studied. Santa María la Blanca has five aisles and therefore four arcades. Both the Cristo de la Luz and the mosque of Tomerías have a square plan with three aisles in each direction, separated by two arcades of three spans, also in each direction. It is a very interesting typology.

Besides the characteristics regarding the number of arcades and arches, in **table 2** the geometrical parameters are also included: lowering of the arch, radiation centre of the voussoirs, existence of wall-embedded work for wall junctions and the presence of a surround, as well as the characteristics of the material used. The lowering of the arch is also variable, although the most frequent value is that of half the radius. A comparative study is shown in **table 3**. In the cases where the lack of cladding has allowed us to see the brickwork, it can be observed that these are arches radiating from the centre of the impost line and with a horizontal wall-embedded work solution, except in the case of El Cristo de la Luz where the radiation centre coincides with the lay-out of the arch.

HORSESHOE BOWS IN THE EXTERIOR OF APSES AND TRANSEPTS

In Toledo there is an interesting series of brick apses, in many cases with horseshoe arches, which have been included in this study so as to systemize the compositional organization. First, a distinction has to be made between the apses with circular plan, corresponding to the presbytery, and the possible existence of a transept of squared or rectangular plan located between the apse and the corresponding aisle. In both cases, it can be one apse – in churches of only one aisle - or three, the central one and two lateral ones, i.e., in three aisled churches. In many occasions, one apse has disappeared, commonly the central one, due to later transformations. **Table 6** shows the characteristics of these bows, analysed. The first twelve cases studied, as well as the two last ones, correspond to the most common Toledo typology, whereas the three other ones are different.

The apses and transepts of the common Toledo typology are formed by a series of orders, stacked in height. There are elements from one and up to four orders. Each order is organized in double bows – the exterior one greater than the interior one - separated by the corresponding piers made of brickwork. The bows can be round arches *C*, circular horseshoe arches *H*, pointed horseshoe arches

A and foiled arches (normally with seven foils). The bows, as has been mentioned before, are double and this allowed us to make different geometrical compositions among them. The combinations found are: *C+C*, *A+C*, *A+H*, *A+P* and *A+A*. (figs. 2 and 3).

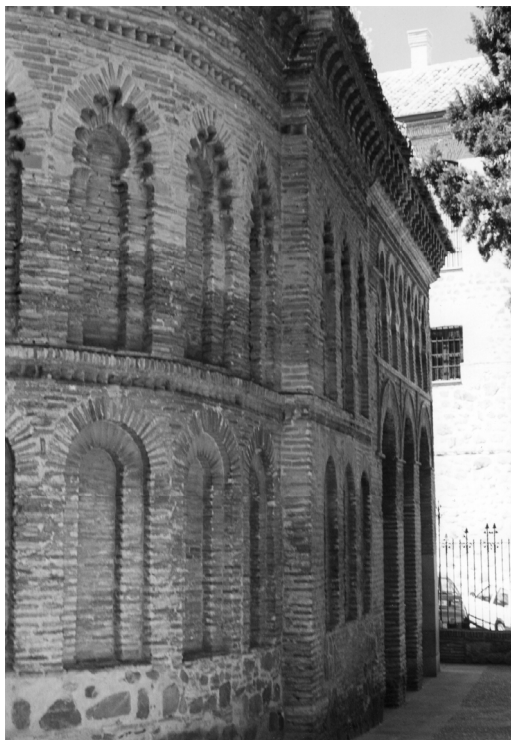


Figure 2. Cristo de la Luz, example of the apse and transept with bows.

In each order, the same type of double bow is repeated, and there seems to be a constant pattern of attributing a double bow to each of the orders. In this way, the first order, except in the case where there is only one, is composed of *C+C* except for one occasion when *A+P* appears. The second order is organized with *A+P* except for the case where *A+H* appears. The third order is composed of *A+H* in three cases, and *C+C* in one, and *A+C* in another case. There is only one apse with three orders (according to some critics, the last one was added later), and this last case is composed of *C+C*.

The apse of Santa Úrsula clearly does not belong to the series, although in the upper part of the blind masonry work, it presents several windows with an organization type *A+P*. Therefore, it has been included in the table as a second order, with the precise indications. The apses of Santa Fe, and of the convent of Concepción Francisca have also a bow, but it is formed just by one order occupying a greater height, and covering the whole façade.

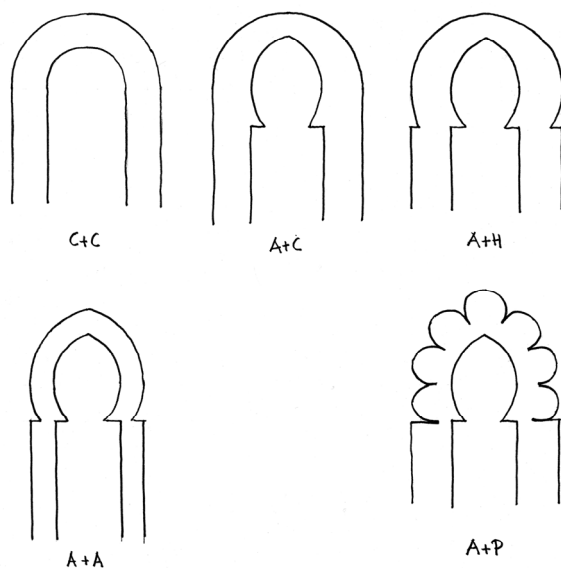


Figure 3. Typology of brick bows in apses and transepts.

It has to be noted that the double bows studied here can appear also in the interior part of the matching elements, with a greater or smaller correspondence with the external composition. Nevertheless, in most cases the later transformations or the placement of the altarpiece have changed or have left them out. For this reason, those arches have not been analysed in the present study, since it only refers to the external organization of the horseshoe arches.

OTHER HORSESHOE ARCHES

The horseshoe arches analysed to date are just part of the wide range of them present in Toledo. Therefore, we would like to mention some others that are also relevant, although being conscious that studying all of them would not be feasible in a research project like this.

First, the pointed horseshoe arches: Several examples of these appear on the city wall gates, and some have even been subject to analysis by our students. This type of arch appears on the exterior façade of the Alfonso VI gate (also called *Bisagra vieja*), with the presence of two upper lateral brick arches. Also, these arches appear on the external long loophole (*buhadera* in Spanish) of the Puerta del Sol, made of stone; on the upper arch of the interior façade of the exterior Tower of San Martín Bridge, and on the porch of San Servando castle, made of brick. The three last cases are arches with a noticeable span. From a more domestic perspective, we can find a pretty example of a pointed horseshoe arch at the Casa del Temple.

In many of the brick towers of the Toledo churches - some of them come from old minarets—show small windows crowned by arches or bows similar to the ones appearing in the apses. As example of these ones, the towers of Santa Leocadia, San Sebastián, San Román, Santo Tomé, Santiago del Arrabal, San Miguel el Alto, San Bartolomé, San Pedro Mártir and Concepción Francisca can be included. These are a very interesting group that should be studied in relation to the brick apses. At the Cenizal Baths horseshoe arches can also be seen, but with the distinctiveness of having also horseshoe vaults. Probably, in some closed convents of Toledo, there are horseshoe arches, which have not been catalogued.

Some Mudejar palaces from the fourteenth century, which widely use Arabesque plaster claddings show some arches difficult to classify. These are somehow in between stilted arches and horseshoe arches. Precise equipment should be used to make a correct and proper drawing of these arches in order to clarify this. One last example should be pointed out, that of a brick arch that appeared during reconstruction works at the Town Hall. It appeared in the second bay, and due to the loss of its springing course, it is difficult to state whether it is a horseshoe arch or not. Nevertheless, we are inclined to think, that looking at the other characteristics it is definitely a horseshoe arch.

This study has been consciously limited to medieval examples, although by the end of the nineteenth century and the beginning of the twentieth century in Toledo the neo-mudejar style used the horseshoe arch extensively. Examples of this period are the ones found at the Bullfight ring, the railway station, and the *Reconquista* School. The arches constructed after this period have not been included either. The use of them was due mainly to an interest in a revival reusing old elements, as can be seen in the porch of Venicazón Palace.

PRACTICAL APPLICATIONS OF THE HORSESHOE ARCH ANALYSIS

The method of analysis carried out, studying the formal, geometrical and constructive characteristics of the horseshoe arches, as well as the information obtained from the studied examples has allowed us to make a similar study applied to the arch of the city gate of Valmardón. It presently shows a circular directrix, but the odd disposition of the stone ashlar made the researcher J.Porres (1988) think, that the horseshoe arch was possibly modified by the off-setting of the impost to become a round arch. **Figure 4** shows the analysis performed, proving that the study of the parameters can certainly support that thesis. Therefore, this arch has been included in the corresponding tables as another horseshoe arch.

A comparison has also been made between the arches of the gate of Alfonso VI (also called *Bisagra vieja*) and Vado Gate, recently discovered in the city wall, not far from the previous one. The volumetric and compositional studies have verified that they are very similar and probably from the same period. Indeed, the succession of spaces – interior gate, chamber, portcullis, double chamber, and external arch - confirms this. Both horseshoe arches have many similarities, even though they

are not exactly equal. Both exterior arches are made of granite, their voussoirs are laid out from the centre of the impost line, they both have a lowering of $\frac{3}{5}$ from the radius and both have a lateral wall-embedded work solution to join in with the wall. Nevertheless, the height varies: in the Alfonso VI Gate it is $\frac{2}{3}$ from the radius and in the Vado Gate it is $\frac{7}{6}$ from the radius.

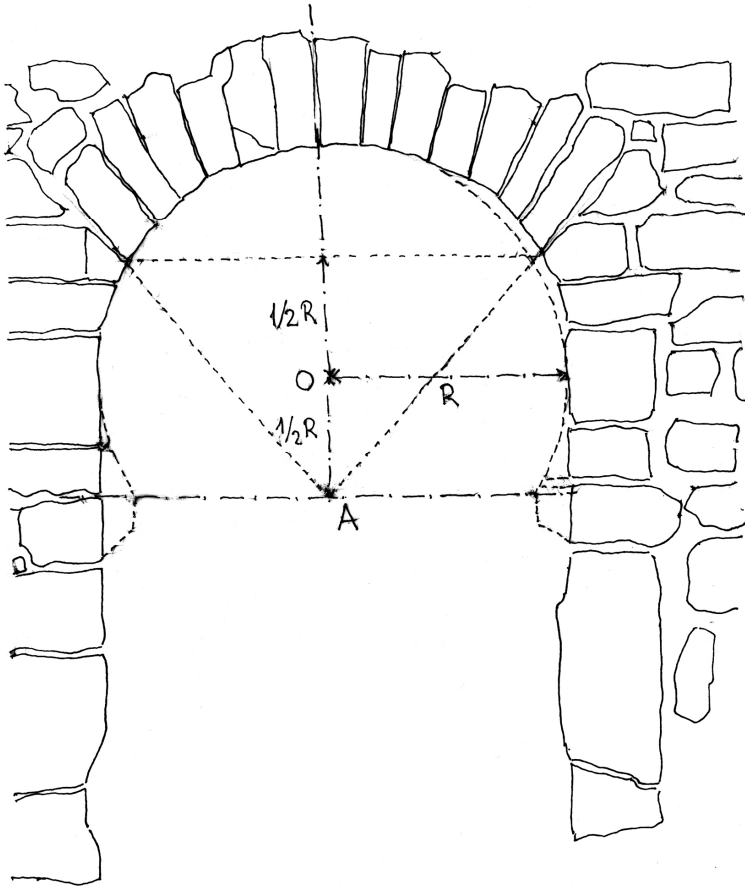


Figure 4. Study of the geometrical layout of the Valmardón gate.

Comparing the interior arches, it can be noted that both are made of brick and laid-out from the centre of the impost line, but the Alfonso VI one has a lowering of $\frac{2}{3}$ with horizontal voussoirs at the springing line and up to a height of $\frac{1}{10}$ m from the radius, with the absence of extrados displacement. At the same time, the Vado Gate presents a lowering of $\frac{2}{3}$ from the radius; the extrados is displaced $\frac{1}{4}$ from the radius and has no horizontal voussoirs. These small differences should be further studied with more precise planimetric data than the ones available for the Vado Gate, but they should be considered as a first approximation to the matter of this study.

Table 1. Circular Horseshoe arches in gates, porches and transverse arches

LOCATION	D/R arch lowering	E/R extrados displacement	I/R horizontal work height	Radial voussoirs from the centre		Material					Characteristics			
				of the arch <i>O</i>	of the springing line	brick	granite	limestone or marble	render or stucco	opus africanus	surround	upper lacing	restored	Notes
CITY WALL GATES														
Sangre arch, interior	1/2	0	1/2		+	+						+		+
Judería bow	1/3	0	0		+	+								(1)
Alcántara bridge, lower bow	1/2	0	1		+		+							
Alcántara gate, arch at angle	1/2	0	1		+	+					+			+
Alcántara gate, exterior arch	1/2	0	0		+		+				x			+
Alcántara gate, rear arch	1/2	0	1		+	+					+			+
Alfon. VI gate, btwn. chambers arch	2/3	0	1/10		+	+					+			
Alfonso VI gate, low exterior arch	3/5	0	2/3		+		+				+	+		(3)
Alfonso VI gate, loophole exterior	1/6	0	0		+	+						+		
Sol gate, low rear arch	2/3	1/6	0		x		+				x			(4)
Sol gate, low exterior gate	1/2	0	7/6		+		+				+			
Vado gate, btwn. chambers arch	1/2	1/4	0		+	+								
Vado gate, exterior arch	3/5		7/6		+		+							(5)
Valmardón gate, city entry arch	1/2	0	1		+		+				+			(6)
ext. tower S.Martín, exterior arch	2/5	0	2/5	+			+							
ext. tower S.Martín, rear arch	3/5	0	1/4	+	+		+							(7)
BUILDING PORTALS														
S.Servando castle, gate	1/2	0	0		+	+						+		+
Cristo Luz, right gate to street	2/5	1/3	0	+		+						+	+	
Cristo Luz, three gates to garden	1/2	-2/3	1	+		+								
San Andrés, lateral gate	1/2	0	5/4		+	+						+	+	+
San Román, gate	2/3					+								(*)
Santiago arrabal, main gate	1/2	0	0		+	+						+	+	+
Santiago arrabal, side gates	1/2	0	0		+	+						+	+	+
Sta. Justa, gate remains	2/3	0	4/3	+				+						
Sta. Leocadia, gate	2/3	0	0		+	+						+	+	+
INSIDE FOORS AND TRANSVERSE ARCHES														
Transverse arch in San Vicente	1/3					+								+
Central transverse arch in Sta. Eulalia	3/4					+								+
Side transverse arches in Sta. Eulalia	2/3					+								+
Doble arch in Sta. Clara convent	4/5								+				+	(*)
Arch in Bulas Street, 21	2/3	1/3			+	+			+					(9)

- (1) The springing of line is modified to reconstruct a horseshoe, as other characteristics show.
- (2) Presence *opus africanus* in one of the sides.
- (3) Horseshoe supports a stone lintel
- (4) Upper voussoirs radiate from the centre at springing course, and lower ones from 1/6 over R
Opus africanus on the sides.
- (5) Cannot precisely identify whether the extrados is displaced regarding the intrados.
- (6) Presently round arch. The data refer to the horseshoe restitution mentioned in the text.
- (7) Shows a slight elliptical shape.
- (8) There is another very similar lateral gate, without interlacing nor surround, in the Gospel of aisle.
- (9) The brickwork structure presents wall embedded work. The decoration simulates an arch with radial voussoirs from the centre of the springing course.
- (*) Reliable geometrical data unobtainable from the arch brickwork.

Table 2. Arcades separating aisles and cloisters

LOCATION	number of arches	D/R lowering of the arch	Radial voussoirs from centre		Denticulation	Material		Surround	Notes
			Of the arch <i>O</i>	Of springing line <i>A</i>		Brick	Render or paint		
San Andrés	6+6	1/4		+	+	+			(1)
San Lucas	4+2	3/5					+	+	*
San Román	3+3	4/5					+	+	*
Santa Eulalia	2+2	1/2		+	+	+		x	(2)
San Salvador	8	2/3		+	+	+			
San Sebastián	6+6	1/2		+	+	+			
San Vicente	5+5	1/2		+	+	+			
Cristo Luz	3+3&3+3	1/2	+		+	+	+		
Tornerías	3+3&3+3	1/3		+	+	+			
Santa María la Blanca	7+7+7+7	1/3					+		(3)*
Claustro de Santa Clara	5+5+5+5	1/2		+	+	+	+	+	

- (1) Church very much reconstructed in different time periods. Arches are very diverse. The most frequent one is taken as reference.
- (2) Surround every two arches
- (3) Extrados is displaced regarding intrados. In the arcades, the first arch is a pointed horseshoe arch.
- (*) The original state is impossible to define due to brickwork being rendered

Table 3. Lowering under the impost line in Horseshoe arches in Toledo

LOWERING RELATION TO RADIUS D/R	1/6	1/4	1/3	2/5	1/2	3/5	2/3	3/4	4/5	Add.
NUMBER RELATION	0,16	0,25	0,33	0,40	0,50	0,60	0,66	0,75	0,80	
Nº of cases in wall gates	1		1	1	5	3	2			13
Nº of restored gate in Alcántara gate					3					3
Nº of cases on building portals				1	5		3			9
Nº of cases in interior gates and transverse arches			1				2	1	1	5
Nº of cases in arcades btwn. Aisles and cloisers		1	2		5	1	1		1	11
Total number of studied cases	1	1	4	2	18	4	8	1	2	41

Table 4. Extrados displacement in Horseshoe arches in Toledo

Displacement in relation to the radius D/R	Without displacement	1/6	1/4	1/3	2/3	Add.
Number relation	0	0,16	0,25	0,33	0,66	
Nº of cases in wall gate arches	13	1	1			15
Nº of cases on building portals	6			1	1	8
Total number of studied cases	19	1	1	1	1	23

Table 5. Wall embedded work, horizontal voussoirs and its height in Horseshoe arches in Toledo

Horizontalvoussoir height I/R	0	1/10	1/4	2/5	1/2	2/3	1	7/6	5/4	4/3	No data	Total with wall emb. work	Add
Number value	0	0,10	0,25	0,40	0,50	0,66	1,00	1,16	1,25	1,33			
Nº of cases without wall embedded work in wall arches	5												5
Nº of cases in wall arches with horizontal voussoirs		1	1	1									3

Horizontalvoussoir height I/R	0	1/1 0	1/4	2/5	1/2	2/3	1	7/6	5/4	4/3	No data	Total with wall emb. work	Add
N° of cases with denticulation in wall arches					1	1	4	2				8	8
N° of cases without wall embedded work on building portals	4												4
N° of cases with wall embedded work on building portals							1		1	1		3	3
Wall embedded work in arcades											8	8	8
Total number of cases	9	1	1	1	1	1	5	2	1	1	8	19	31

Table 6. Brick Horseshoe bows on the exterior of apses and transepts

LOCACIÓN	TIPO	1° ORDER	2° ORD	3° ORD	4° ORD	NOTES
Cristo Luz	Abs + Cr.	C+C	A+P			
Sta. Justa	Abs.	C+C	A+P			
Sta. Leocadia	Abs.	C+C	A+P	A+H		
Cristo Vega	Abs + Cr	C+C	A+P	A+H	C+C	
San Vicente	Abs + Cr	C+C	A+P	C+C		
San Bartolomé	Abs Cr	C+C C+C	A+P A+P	A+H		
Santiago del arrabal	Abs + Cr Abs + Cr	C+C C+C	A+P A+A	A+C		central 2 lateral
Sta. Isabel	Abs. Facade	A+P A+P	A+H A+P			S. Antolin
San Eugenio	Abs.	A+H	A+P			
San Lázaro	Abs.	A+C				
La Magdalena	Abs.	A+H				
Santa Úrsula	Abs.		A+P			Windows
Santa Fe	Abs.	Simila A+H				Upper lacery
Concepción Francisca	Abs.	similar A+P				
San Román	Cr					Remains
San Cipriano	Abs.					No data

C semi-circular bow, H circular horseshoe bow, A pointed horseshoe bow, P polyfoiled bow, Abs. Apse, Cr Transept

Table 7 List of students who have participated in data collection of the horseshoe arch in Toledo

Ref. Location	<i>Students of the School of Architecture, Madrid</i>
A Cristo Luz (interior)	Escartín Garrido,M; Baselga Loring,J
B Cristo Luz (right street)	Niharra, Pablo; Abenza, Jesús
C Cristo Luz (garden)	Arenas Trrente, Is.; Sama Rojo, Adair
D Bisagra vieja (centre outside)	Agenjo Díaz, Laura; Castro Carrasco,A
E Bisagra vieja (centre upper outside)	Blázquez Gómez,David; Rama Toribio, Julio J.
F Bisagra vieja (Lateral upper outside)	Fuentes González, Paula; Millán Angles, Susana
H Bisagra vieja (interior)	Estevez Martí,J ; García Arribas, I; Travesí Matías, C
I Sol gate (low exterior arch)	Alcauza Moreno,Ana; Ruiz Crespo, Laura
J Sol gate(exterior upper arch)	Cristobal Sánchez, Raquel; López Paniagua, Lidia Sánchez Sánchez, Javier
K Sol gate(rear arch)	Morales Cas, C; Prado Benayas, L; Zapata Viñuelas,T
L Santiago arrabal (main gate)	Blanco Brotons, F; Eizaguirre Santillán,Jaime
M Santiago arrabal (lateral gate)	Iglesias Maqueda,Carmen; Del Campo Martín, Aránzazu
N Alcántara gate (exterior)	Castaño Asensio, Sara; Fernández
Ñ Alcántara gate (interior)	Moreno Sánchez, David; Torrijos, Carlos
O Alcántara gate(lower arch)	Gómez Friha, Sofia; Gozález Jiménez, David Reynolds Álvarez, María
U S.Martín gate (exterior outside tower)	Almodóvar Aráez, Ana; Arcos Jiménez, Israel
W Santa Justa	Melero Pérez, Jesús; Morillas Fernández, Alicia
Z San Andrés	García Urquijo, Samuel
x Alcántara gate (round arch)	Delgado Tejedor,Marta; Marcos Nieto, Luis

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