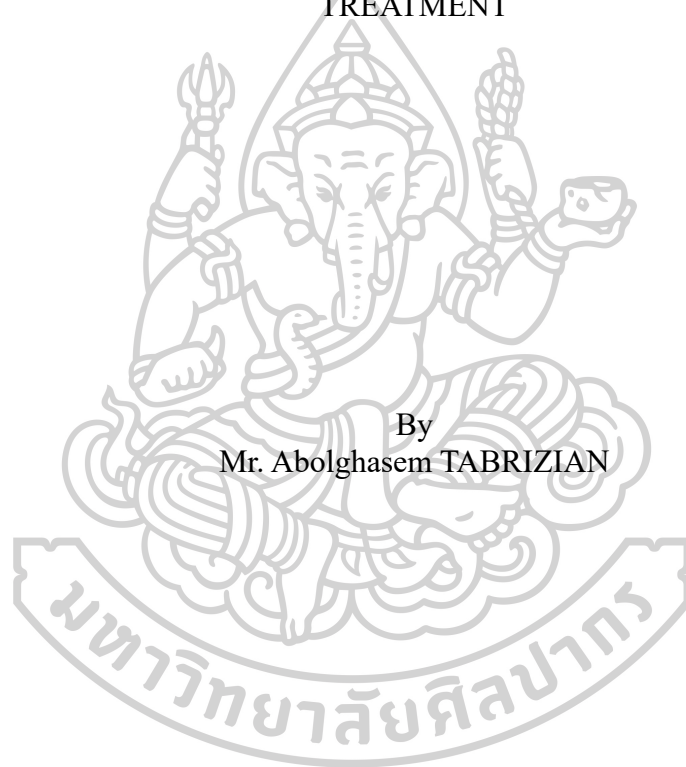




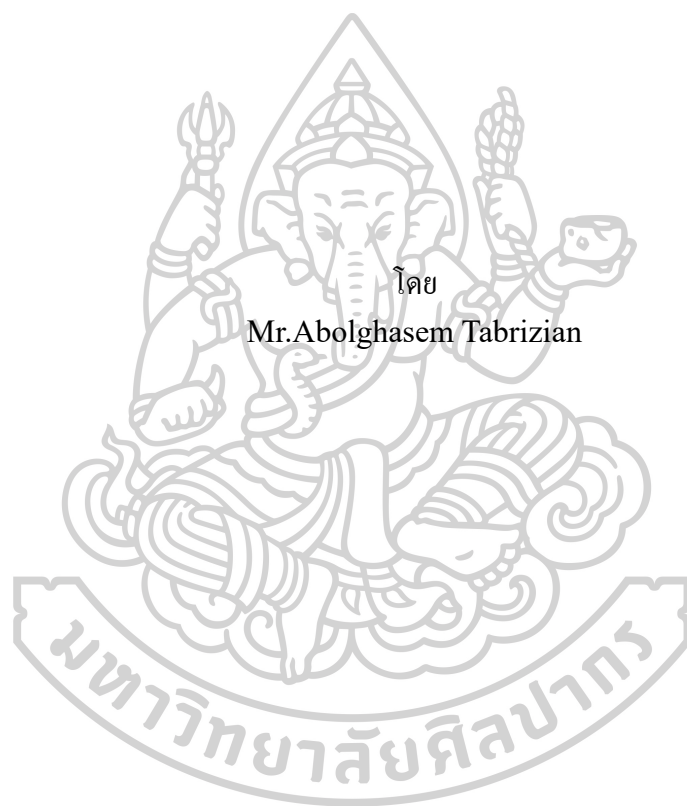
A HAND-KNOTTED CARPET (1900) FROM HAM ADAN IRAN  
INVESTIGATION, CONCEPT FOR CONSERVATION AND EXEMPLARY  
TREATMENT



An Independent Study Submitted in Partial Fulfillment of the Requirements  
for Master of Arts CULTURAL HERITAGE CONSERVATION AND  
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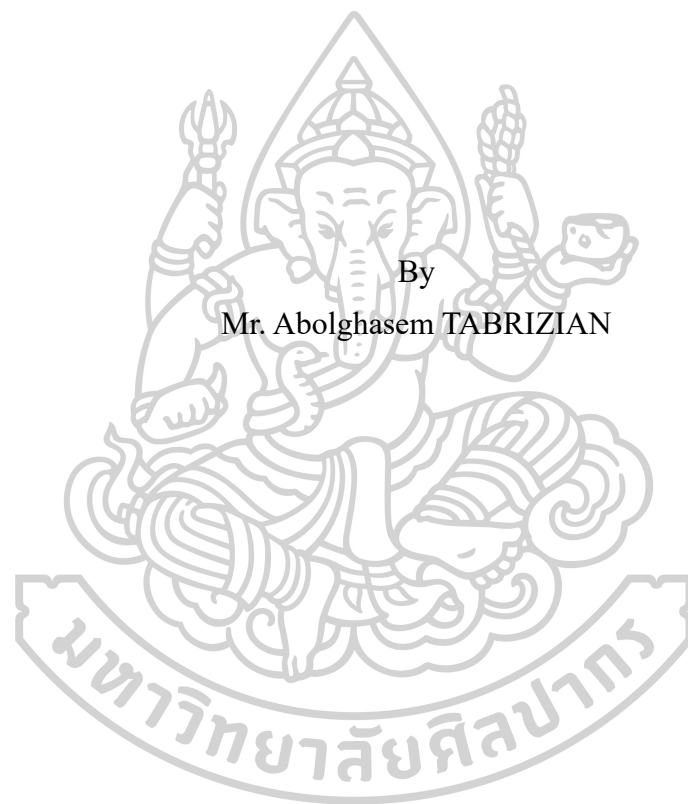
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ลิขสิทธิ์ของมหาวิทยาลัยศิลปากร

A HAND-KNOTTED CARPET (1900) FROM HAM ADAN IRAN  
INVESTIGATION, CONCEPT FOR CONSERVATION AND  
EXEMPLARY TREATMENT



By  
Mr. Abolghasem TABRIZIAN

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Keyword : conservation restoration carpet Iran Hamadan

Mr. Abolghasem TABRIZIAN : A Hand-Knotted Carpet (1900) from Ham  
Adan Iran Investigation, Concept for Conservation and Exemplary Treatment Thesis  
advisor : Thanya Lunchaprasith, Ph.D.

A Hand-knotted Carpet (~1900) from Hamadan, Iran

Investigation, Concept for Conservation, and Exemplary Treatment

A private collector gave the Hamadan hand-woven carpet (~1900) to the Institute of Conservation, University of Applied Arts Vienna, to investigate and improve its condition. There is no previous documentation. In the first chapter, comparative research is used to try to determine the origin of the carpet. The materials and technology of the object were explored in the second and third chapters, and then a small section of the object is restored as a model. Using this strategy, object defects are uncovered. The conditions of surveillance are defined in chapter 4. The object is damaged in eight places. Selvage also has several abrasions. According to the carpet's owner, the aim is to reuse the object, so restoration of the roots, tear, and selvage is prioritised. The notion of protection in chapter 6 serves as a guideline for practical restoration in chapter 7. Traditional and academic methods are applied to restore the object in selected parts.



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Because of the joys, traditional dances, hospitality, and rich culture

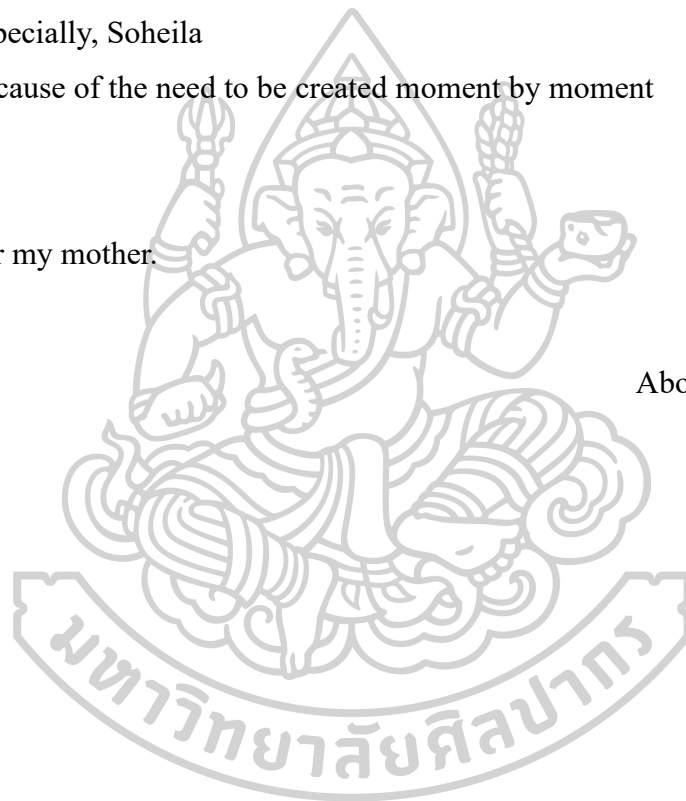
All of the temples  
The routes we took together  
For Memorable Bangkok with you

And my brother, Khánh Nguyen Quang (Kim),  
For all the moments we walked together and watched the world from the same  
window

Especially, Soheila  
Because of the need to be created moment by moment

For my mother.

Abolghasem TABRIZIAN





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## INTRODUCTION

Iranian carpets, which have a long and rich history, are one of the most precious handcrafted objects in Iran. They provide a platform for Iranian talent and culture. Their aesthetic components eventually became so popular that many museums and collectors began collecting them. Concerns regarding conserving and recovering carpets for exhibition and durability arose simultaneously and have remained critical ever since. Carpets have been damaged and sometimes destroyed throughout the years. However, restoration and conservation techniques have been utilised to keep them preserved.

The Hamadan hand-woven carpet (~1900) was given to the workshops of the Institute of Conservation at the University of Applied Arts Vienna by a private collector living in Vienna to restore the damaged parts and improve its condition. The object does not have a certificate registration number and also does not exist other information. As a result, this thesis examines the object and its protection methods by presenting a study and conservation plan in seven chapters so that the object can be protected and restored. In the first chapter, comparative studies are used to try to pinpoint the origin of the carpet. Library studies are based on the matching of patterns, motifs, and object colouring for this goal.

The materials and tools used in carpet weaving in Iran, particularly in the Hamadan region, are discussed in the second chapter. The tools used in carpet weaving have a direct effect on the quality of the woven carpet. Sufficient knowledge about this can clarify the reasons for defects that occur during weaving.

Technological survey is covered in the third chapter. The technical features of a historical artefact can be revealed by recreating a small portion of it. The laboratory method of identifying the materials used in the object, as well as checking the carpet weaving procedures, is useful and practical for this operation. This evaluation can also identify weaving defects.

The conservation and restoration solutions can be determined by identifying the damages and their extent. This is covered in a separate chapter called Condition Survey. Natural-material objects like carpets are constantly vulnerable to physical or chemical deterioration. This chapter investigates carpet damage.

The types and extent of damages and expenses to be displayed help prioritize practical activities. This method is critical to the decision of the object's owner as well as subsequent research to determine the aim of conservation. This topic is covered in detail in Chapter 4. In Chapter 5, the aim of conservation and restoration determines the scope of practical action.

The private owner's perspective on the restoration process is critical. Considering that the owner intends to use the object again, the concept of conservation is discussed in the sixth chapter. The concept of conservation entails a set of dos and don'ts. This chapter is based on library research and an examination of traditional restoration methods and academics. The most effective conservation and restoration strategies are selected based on the findings in this chapter. The seventh chapter, which covers the practical side of restoration, comes after the studies from the sixth chapter.

The findings of other researchers are analysed to assess them and begin studies. The early chapters concentrated on object technology and condition surveillance. Written information about the different sorts of damage and defects on the carpet or during the weaving process was reviewed. However, because the researchers did not use these defects as a case study, there are fewer photographs related to the explanations in the sources.

Finally, the review, study, and classification of the information from the practical process with a focus on the restoration and protection of the roots put tars and selvage. In the restoration of these three damages, studies are carried out using traditional and academic restoration methods, and finally, practical work is done based on the standards. While protecting cultural features, the carpet owner's comments are taken into consideration at all stages of the work.

## 1. A hand-knotted carpet from Hamadan (~1900)

3

### 1. A hand-knotted carpet from Hamadan (~1900)

The carpet was given to the Institute of Conservation's workshops at the University of Applied Arts Vienna by a private collector who resides in Vienna so that it could repair the damaged areas and improve its conditions (Fig. 1). The object lacks an identity card or registration number. Little details concerning the carpet have been given to the Institute. As a result, it is not clear which country or region the object belongs to. The carpet shows geometric designs. The carpet's border is brown, and the background is red. Its materials are unknown. Preliminary findings indicate that the carpet might be from Iran's Hamadan region. But more research is necessary to learn more about the object.

Artist: Unknown  
Title/Description: Hand-knotted carpet from Hamadan, Iran  
Technique: Simetrical knotting  
Dimensions: 192 x 118 cm  
Dating: About 80 to 100 years  
Provenance: Hamadan province, Iran  
Owner: Private collector



Figure 1 : Hamadan carpet (~1900).

#### 1.1. Description of the object

After studying and comparing with other historical carpets, the studied carpet has been identified as a carpet from Iran and the Hamadan region due to its structural features, motifs, colouration, and knotting technique. This carpet belongs to nomadic people who moved around in the summer and winter. The combination of motifs in several areas on the carpet's edges and the weaving technique give information about that.<sup>1</sup> The

<sup>1</sup> Jalilian, Naeime, and Abutorab Ahmadpanah, and Mahmoud Haji Nasiri. 2013. "Investigating Hamadan Woven Rural Carpet Patterns." Master thesis, Semnan University - Faculty of Art and Architecture.

## 1. A hand-knotted carpet from Hamadan (~1900)

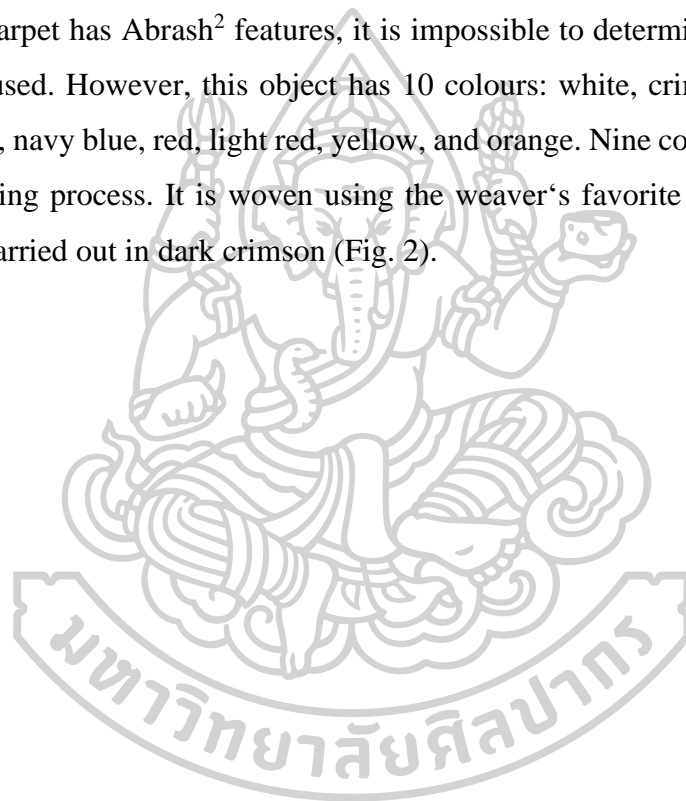
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creator of this carpet is unknown. It appears that this carpet is 80–100 years old. Cotton has been used for the warp and weft, and wool for the knots. The carpet knot has perfect symmetry.

Traditionally, the Hamadan region's carpet designs were woven patterns that already existed rather than being drawn on paper. This feature makes it easy for the weaver to stick to the pattern and simplifies the knotting. The carpet has abstract motifs, following its cultural region-inspired motifs and patterns. Every motif is symbolic and conceptual. The motifs of this carpet are symmetrical.

Since this carpet has Abrash<sup>2</sup> features, it is impossible to determine the exact number of colours used. However, this object has 10 colours: white, crimson, light and dark brown, blue, navy blue, red, light red, yellow, and orange. Nine colours have been used in the knotting process. It is woven using the weaver's favorite ideas and hues. The selvage is carried out in dark crimson (Fig. 2).



---

<sup>2</sup> Abrash is a Persian word that refers to a type of carpet with different shades and colour tones. This term refers to a horse that has different colour spots from its original skin colour. Its English equivalent is Brindle Horse.



1. A hand-knotted carpet from Hamadan (~1900)

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Figure 2 : The historical carpet.

## 1.2. Comparable carpets

One of the rugs with rural and urban styles is the Hamadan carpet. This carpet has a symmetric knot with a cotton warp and a wool pile. Hamadan carpets typically come in

1. A hand-knotted carpet from Hamadan (~1900)

6

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red, (Fig. 3)<sup>3</sup> blue, navy, beige, yellow, white, orange, and cream colours and features overall flower designs and in-and-out fish designs. Typically, the carpets made in this province go by the generic name of Hamadan (Fig. 4)<sup>4</sup>. Every section of the province of Hamadan has its distinctive carpets, which are famous in Iranian markets under the names of the same village or town.



Figure 3 : Hamadan carpet, (Red Runner) 20 century.



Figure 4 : Hamadan carpet, 20 century.

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<sup>3</sup> Rugman.Com. 2023. "Hamadan Red Runner Hand Knotted 3'10 X 14'5 Area Rug 100-20552." Accessed January 10, 2023. <https://www.rugman.com/carpet-design/hamadan-rugs/14-ft-runner-persian-hand-knotted-red-wool-sku-20552.html>.

<sup>4</sup> Rugman.Com. 2023. "Hamadan Red Runner Hand Knotted 2'9" X 13'10" Area Rug 100-74894." Accessed January 10, 2023. <https://www.rugman.com/carpet-design/hamadan-rugs/13-ft-runner-persian-hand-knotted-red-wool-sku-74894.html>

The breadth and diversity of Hamadan's patterns and motifs should be considered a result of the participation of the people and the native spirit of the villagers in different regions. (Patriotism) Cities such as Anjalas, Bibikabad, Darjezin, Kaboderahang, and Bezchelo, each of which has produced and performed beautiful and diverse roles at an excellent level are famous and popular in the name of the same region. The designs woven in each village are known and sold under the name of the weaving area, which are: Asad Abad, Enjilas, Bi Bikabad, Mehraban, Kabudarahang, Boz-chelu, Darjazin, Hosseinabad, and Etc.<sup>5</sup>

Although the rural carpets of Zagheh, Malayer, and some of the Lilian carpets are similar to the carpet in this thesis among the carpets of the urban and rural areas of Hamadan, the carpets of the areas of Asadabad, Enjilas, Hossein Abad, and Bibik Abad share a lot of characteristics. Other regions' carpets are similar in terms of knotting methods and materials, but they are different in motifs and patterns. The carpets in these four regions will be discussed in the paragraphs that follow.

### 1.2.1. Asad Abad

The Asad Abad carpet has similar traits to other rural carpets from the Hamadan region. An asymmetrical knot made of cotton thread and wool pile is used in this carpet. Its common hues are red, blue, navy, green, and white. In and out fish design, medallion design corner and geometric design (one or more medallions in the middle of the carpet), and geometric design are other common designs.<sup>6</sup> Red is the dominant colour (Fig. 5–6).<sup>7</sup>

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<sup>5</sup> Jalilian, Naeime, and Abutorab Ahmadpanah. 2013. "The Impact of Religious Beliefs and Myths on Rural Hand-woven Rugs of Hamadan." *Goljaam* 8, no. 22 (November): 7-18.

<sup>6</sup> Sooresrafil, Shirin. 1996. *Pattern History of Hamadan Carpet*. Tehran: Mina.

<sup>7</sup> Ahmadcarpets.com. 2020. "Asad Abad Hamadan Hand-woven Carpet with a Fish Design." Accessed February 12, 2023. <https://ahmadcarpets.com/43754/>





Figure 5 : Asad Abad Hamadan hand-woven carpet, (about 20 century).



Figure 6 : Behind the carpet.

The Asad Abad carpet is the one that most closely resembles the carpet in this thesis among the comparison carpets that have been shown. Each fish<sup>8</sup> has a consistent form. They share the same (L-shaped) shape, colour scheme, and pattern. The carpet's corners have a distinct personality of their own. The same arrangement and composition of the frame and turtle motifs are used to decorate the carpet's border as well. Additionally, the colour and motifs themes are pretty similar. This carpet's thin linear frame is also woven with a pattern that alternates between light and dark spaces and gives a checkerboard appearance. Rhombuses, fish, and flowers all play significant roles in this carpet, and their significance is comparable. Therefore, it would seem that the nomads of Asad Abad village are the ones who manufactured the carpet that was the subject of this thesis.

### 1.2.2. Enjilas

The Enjilas area, in the southern region of Hamadan province, is where the Enjilas carpet (also known as the Injelas Rug) is woven. This carpet has an asymmetric knot with a cotton warp and a wool pile. The typical patterns for Enjilas carpet include the in and out fish design, Boteh Miri, and medallion designs with corners.<sup>9</sup> The typical

<sup>8</sup> Appendix I, page 94, has information about Asad Abad carpet patterns and motifs.

<sup>9</sup> Appendix I, page 96, has information about common patterns and motifs.

1. A hand-knotted carpet from Hamadan (~1900)

9

colours are red, blue, navy, and white. Herati is the most common pattern found in Enjilas rugs (Fig. 7–8)<sup>10</sup>. These rugs are very similar to Hossainabad rugs.<sup>11</sup>



Figure 7 : Enjilas Hamadan hand-woven carpet, (about 20 century).



Figure 8 : Details of the corner.

<sup>10</sup> Ahmadcarpets.com. 2020. "Enjilas Hamadan's Hand-woven Carpet with a Fish Design." Accessed February 12, 2023. <https://ahmadcarpets.com/45149/>

<sup>11</sup> Rugman.Com. 2023. "Enjilas Hand Knotted Area Rugs." Accessed July 18, 2023. <https://www.rugman.com/carpet-design/enjilas-rugs/>

### 1.2.3. Hossien Abad

One of the carpets made in the Hossein Abad region that has rural features is the Hossein Abad carpet. This carpet uses a symmetrical knot with a wool pile and cotton and wool warp and weft. Reds with different shades, white, and blue are frequent hues in Hossein Abad carpets, as medallion, corner, and fish designs. In comparison to other parts of the Hamadan carpet, the borders of the Hossein Abad carpet are often narrower and have simpler patterns. Small animal motifs or garden designs may occasionally be observed, as well as the renowned Herati pattern. The majority of these carpets have a reputation for lasting unexpectedly long times and are often of quite high quality.<sup>12</sup> When comparing the Hossein Abad and Enjilas carpets, it is evident that the fish motif is shaped like a curled leaf, whereas the fish motif in the Asad Abad carpet is entirely geometric. The fish pattern can also be found combined with other themes. The fish pattern is also combined with other motifs. The fish motif in the Asad Abad carpet is either an individual or a collective (Fig. 9–10)<sup>13</sup>.



Figure 9 : Hossein Abad Hamadan Hand-woven carpet, (about 20 century).

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<sup>12</sup> Rugman.Com. 2023. "Hossein Abad Persian Area Rugs." Accessed January 23, 2023. <https://www.rugman.com/carpet-design/hossein-abad-rugs/>

<sup>13</sup> Ahmadcarpets.com. 2020. "Hossein Abad Hamadan Hand-woven Carpet with Narrow Mosul Size All over Design." Accessed February 12, 2023. <https://ahmadcarpets.com/40033/>





Figure 10 : Behind the carpet.

#### 1.2.4. Bibik Abad

The carpets of Bibik Abad are woven using the single-weft method and are the coarsest carpets in Hamadan. The distinctive sharp head medallions of this region and the big fish pattern they bear are the distinguishing features of their carpets (medallion design: corner, fish design: inside and outside and flower design: overall).<sup>14</sup> Typically, the Bibik Abad carpet is available in hues of red, blue, navy, green, white, orange, and cream. (Fig. 11–12)<sup>15</sup>



Figure 11 : Details of the Bibik Abad carpet, (about 20 century).

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<sup>14</sup> Refer to Appendix I, Photodocumentation

<sup>15</sup> Ahmadcarpets.com. 2020. "Antique Hand-woven Carpet of Bibik Abad Hamadan Design of Medallion Design—Corner." Accessed February 12, 2023. <https://ahmadcarpets.com/42923/>



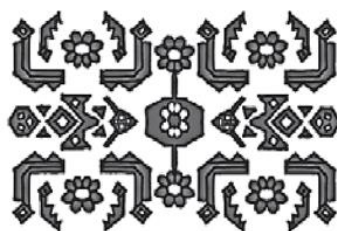
Figure 12 : Bibik Abad carpet.

### 1.2.5. Hamadan motifs

One approach for determining the provenance of carpets is to compare themes. The theme utilized in the object is one of the most prominent characteristics that distinguish it as a Hamadan carpet. Animal motifs, particularly aquatic ones, are represented in Hamadan carpets. Fish (Figs. 13–14), crabs (Fig. 15), and turtles (Fig. 16)<sup>16</sup> intertwined with distinctions in Hamadan's villages and cities.



Figure 13 : Enjilas fish motif.



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<sup>16</sup> Jalilian, and Ahmadpanah 2013, 10-12.

Figure 14 : Kabudarahang fish motif.



Figure 15 : Crabs motif in Mehraban



Figure 16 : Turtles motif in the suburbs of Hamadan.

### 1.3. Cultural and art historical context

About 320 kilometers west of Tehran, in the western provinces of Iran, (Fig. 17)<sup>17</sup> lies the city of Hamadan, also called Ecbatana. Ecbatana is one of the oldest cities in the world.<sup>18</sup> It is one of the major centers for carpet manufacturing. The carpets produced here are known as Hamadan carpets. They are knotted in Hamadan and large quantities in the surrounding towns and villages. Carpets of very high quality are sold under brand names such as Nahavand, Toyserkan, Malayer, Hosseinabad, etc.



Figure 17 : Hamadan Province, Iran.

<sup>17</sup> Rugman.Com. 2023. "Hamadan Persian Area Rugs." Accessed March 18, 2023. <https://www.rugman.com/blog/rug101/hamadan-rug/>

<sup>18</sup> Saidian, Abdul Hossein. 2004. *Iranian Land and People, Anthropology and Customs of Iranian Peoples March 21*, Wednesday. Tehran: Science and Life Publishing Institute.

Ecbatana is located at the intersection of two Iranian mountain plateaus; therefore, numerous tribes and nomadic groups live here, each with their own cultures, and dialects. Motifs of their myths and belief systems are knotted into carpets.<sup>19</sup> The beginning of carpet weaving in Hamadan is not documented, although the development of abstract patterns there is a result of the beliefs of the Medes people,<sup>20</sup> who inhabited the area from approximately 678 BC to approximately 549 BC. Fish and turtles were highly revered by these ancient peoples.<sup>21</sup>

As one of Iran's capitals during the Median, Achaemenid, Parthia, Sassanian, Al-Buye, and Seljuk eras,<sup>22</sup> Hamadan could be regarded as one of the country's most significant carpet-weaving centers. According to historical records, the Safavid Shah Tahmasp (1514-1576 reigned 1524-1576)<sup>23</sup> gave the Ottoman monarch Suleiman a rug made of Darjazin carpet. It appears that four hundred years ago, the people of Hamadan had a high level of carpet weaving proficiency.<sup>24</sup>

Hamadan has a thriving carpet weaving industry and was formerly one of the primary hubs for the trade of carpets in western Iran. Many carpets from central and western Iran have gone to Iraq and Arab cities and Europe through this route.<sup>25</sup> From the point

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<sup>19</sup> Zakai, Parviz. 1973. "Brief about Hamadan Folk Culture and Its Dialect". *Art and People*, January 1, 1973.

<sup>20</sup> Simo, Parpola. 1970. *Neo-Assyrian Toponyms*. Kevelaer: Butzon & Bercker.  
<https://archive.org/details/neoassyriantopon0000parp/page/n9/mode/2up>.

<sup>21</sup> Jalilian, and Ahmadpanah 2013, 11.

<sup>22</sup> Rezaei Hamdani, Emaduddin. 2000. *The Face of Hamadan*. Tehran: Anoushe Publications.

<sup>23</sup> Izadi, Abbas. 2018. "A Visual Study on the Figures of the "Kava Tears Zahhak's Scroll" Painting from Tahmasp Shahnama, According to Gestalt Theory." *Negareh Journal* 13, no. 45 (April): 18-31.  
[https://negareh.shahed.ac.ir/article\\_701.html?lang=en](https://negareh.shahed.ac.ir/article_701.html?lang=en).

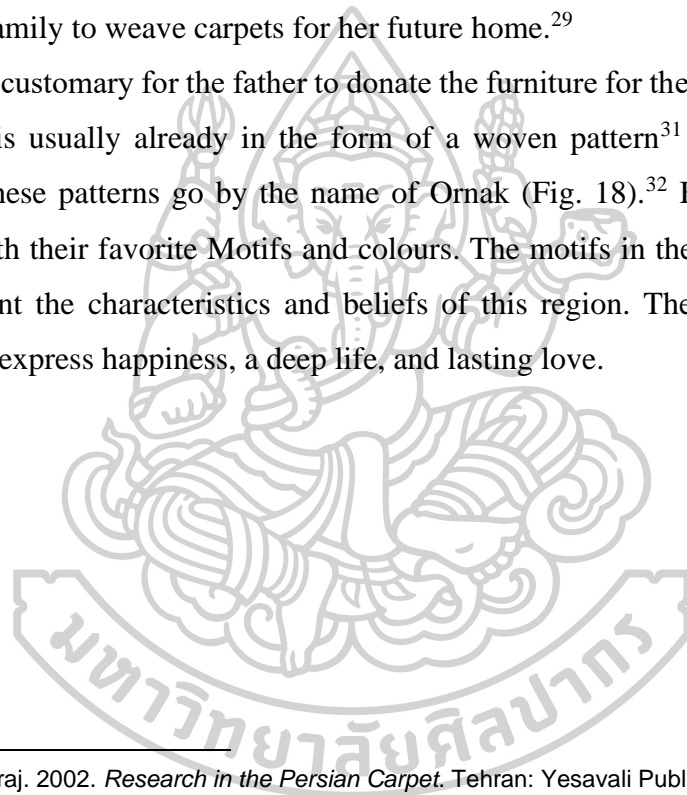
<sup>24</sup> Talebpour, Faridah. 2019. "Investigating the Characteristics of Hamadan Carpet." *Journal of Jelveh-y Honar*, no. 6 (January): 23-28.

<sup>25</sup> Yesavali, Javad. 1991. *An Introduction to the Recognition of Iranian Carpets*. Tehran: Farhangsara.



of view of stylistics, the original Hamadan carpet is rural.<sup>26</sup> According to Cecil Edwards, Hamadan was one of the largest carpet weaving areas.<sup>27</sup> There are two categories of hand-woven carpets from Hamadan: urban weaving and rural weaving. Most of the village carpets around the cities of Hamadan, Tuiserkan, and Nahavand are produced by the method of one weft. The villages along the Malair-Arak Road have two-weft carpets, which can be referred to as Jozan villages. These weavers use symmetrical knots in carpet weaving, which is done without using hooks and with high speed and skill.<sup>28</sup> In the Hamadan region and among the tribes, it is a tradition for the girl of the family to weave carpets for her future home.<sup>29</sup>

In Iran, it is customary for the father to donate the furniture for the bride's house.<sup>30</sup> The map for it is usually already in the form of a woven pattern<sup>31</sup> and is made by the weavers. These patterns go by the name of Ornak (Fig. 18).<sup>32</sup> But each weaver has linked it with their favorite Motifs and colours. The motifs in the carpets are abstract and represent the characteristics and beliefs of this region. The general concept of motifs is to express happiness, a deep life, and lasting love.



<sup>26</sup> Jouleh, Touraj. 2002. *Research in the Persian Carpet*. Tehran: Yesavali Publishing House.

<sup>27</sup> Edwards, Arthur C. 1989. *The Persian Carpets*. Tehran: Farhangsara.

<sup>28</sup> Talebpour 2019, 23-28.

<sup>29</sup> Tavakoli, Maryam. 2018. "Marriage Ceremony among the Bakhtiari Tribe." *Soor Cafe*. Iran Tourism and Iranology Reference. Accessed November 28, 2023. <https://cafesour.ir/travel-to-iran/conventions/>.

<sup>30</sup> Razi, Hashem. 1999. *Vendidad [Vidaevo Data]: Avesta Text, Introduction with Pahlavi Comparison, Translation*. Tehran: Behjat.

<sup>31</sup> Jouleh, Touraj. 2021. director. "Episode 145 60 Sec Rug Tale: Weaving Code With Touraj Jouleh." Facebook, June 23, 2023. <https://www.facebook.com/watch/?v=4077852775586310>.

<sup>32</sup> Daryaie, Nazila. 2018. "Mehr Signs in Persian Rugs Moifs." *Journal of Art and Civilization of Orient (JACO)*, 6, no. 19 (June): 24-31. [https://www.jaco-sj.com/article\\_63586.html?lang=en](https://www.jaco-sj.com/article_63586.html?lang=en)





Figure 18 : Woven pattern (Ornak), (~1900).

### 1.3.1. Patterns and motifs

Although there are several cities and villages in Hamadan province, they all have carpets with distinctive designs or patterns. In general, the patterns and motifs used in these areas can be described as follows: Kabudarahang, Enjilas, Bibik Abad, Hosseinabad, Mehraban, Darjazin, Boz-chelu, Asada Abad, Zagheh, Touserkan,<sup>33</sup> Shahsavan, Jozan, Nehavand, Malayer, and Lilian. Each of these areas follows its own unique patterns, motifs, and color spectrum.<sup>34</sup> Enjilas, (in and out fish designs, bushes, and medallion designs with corners) Bibik Abad (medallion design—corner, In and out fish design, and overall flower design) Mehraban (overall flower design, vase design, In and out fish design, medallion design—corner and Tree,) Kabudarahang (repeating small medallion motifs, medallion design—corner, tree, bush design, and In and out fish design), Boz-chelu (Borchalu Rug) (medallion design corner and in-and-out fish design) Darjazin (Saroghi, bush, and flower design; tree, vase, and types of medallion design; corner) Hossein Abad (medallion design corner, fish design).<sup>35</sup>

The motifs in Hamadan have special meanings and characteristics and show convictions, wishes, beliefs, and life situations. In the Hamadan carpet, motifs are common and woven in an abstract form. The animal motifs in Hamadan village carpets can be divided into the categories of quadrupeds (goat, lion, camel, dog), birds (eagle, peacock, sparrow), and aquatic animals (fish, turtle, crab). Among the three mentioned

<sup>33</sup> Sooresrafil, 1996, 121-160.

<sup>34</sup> Photos of the carpets from each region are included in Appendix I, on page 96.

<sup>35</sup> Jalilian and Ahmadpanah 2013, 8-9.

categories, aquatic animals have taken the largest share, which can show the cultural value hidden in them, which refers to the myths and cultural beliefs in the region.<sup>36</sup>

### 1.3.2. The main sections

Iranian rugs feature abstract patterns. This characteristic facilitates both easier knotting and easier plan compliance for the weaver. It is ingrained in Iranian culture. Iranian literature uses the same style of writing, with the audience being informed of the story by placing the words in the center of flower leaves. Because all of these themes are conceptual and symbolic, the viewer won't be able to understand anything unique about them. Every motif is conceptual and meaningful. The pattern of this carpet is a quarter. It will obtain the other half after symmetrically aligning a quarter of it, and finally the complete carpet's pattern.

In Iranian carpet design, borders are fixed, traditional, and authentic components that significantly contribute to the visual appeal of the carpet. The border of the carpet, according to Iranian carpet designers, is the design's cornerstone. Without a border, the design will not be the main focus of the viewer's attention. The viewer must begin at the edge of the carpet and move towards the center. This route could be mystical or gnostic.

The carpet starts at the border. Simple, wide, and narrow borders, or strips filled with designs, form the border around the carpet (Fig. 19). On the border and in the middle of this carpet are aquatic animals. The border's primary animal motifs are the crab and turtle, while other motifs like fish and flowers can also be recognised. These traits, which are one of the most prominent aspects of Hamadan carpets, reveal the carpet's provenance. On the borders and center of this carpet, the themes that are most interesting to the nomads of this region are weaved in the form of the main character. The precise placement of the motifs in each segment demonstrates the carpet's uniqueness.

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<sup>36</sup> Jalilian, Ahmadpanah, and Haji Nasiri, 2013.

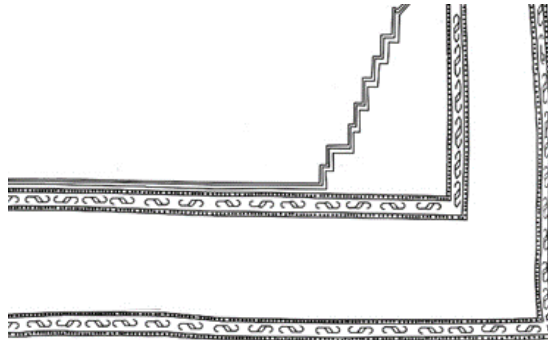


Figure 19: The carpet borders.

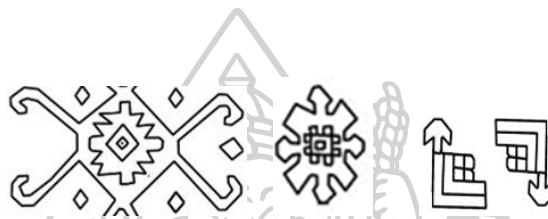


Figure 20 : Aquatic animals (crab, turtle, and fish).

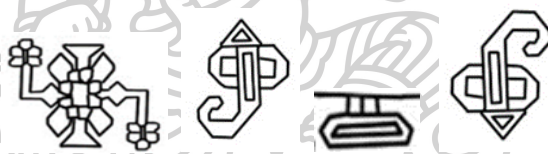


Figure 21 : Three motif liveliness of life.

Aquatic animals have a disproportionately strong presence in nomadic carpets, which can be interpreted as a cultural value alluding to local mythology and cultural beliefs. The turtle (Fig. 20) is a representation of longevity and fertility. For the nomadic people, having numerous offspring and living a long life is significant. The crab (Fig. 20) eliminates evil. Crab is one of the constellations considered by nomads. Fish are used to represent watching over the Tree of Life. There are single or pairs of fish motifs. The fish frequently has a flower on its head or flank. There is a flower in the turtle motif. Three symbols in the border portion mean the liveliness of life (Fig. 21). A flower that waves its hands and dances is the initial motif of a dancer (Fig. 21-22). Intriguingly, flower motifs did not form symmetrically but rather individually, and it can be thought of as a brief and unique animation. The viewer initially notices a flower with its two hands uplifted. Another hand down one hand up, one hand down. Seeing all five flowers

at once is a perfect representation of one dancer. Among the dancing flowers, there are motifs of an eight-petaled flower, a fish, and an S shape. The shape (S) is also woven in a zigzag pattern on the thin border.



Figure 22 : A flower that waves its hands and dances.

Another border symbol is the Adam motif (Fig. 23). An organ from a man's body serves as the motif. The existence of a platform in front of this pattern, which from a different perspective resembles a flower, as a unique and abstract representation of a male and female, this carpet might be regarded as special. The weaver's imagination is where the delights and pleasures of life reside. One-fourth of the pattern in Figure 24 is linear. This pattern specifies the arrangement of the motifs in the center and the borders.



Figure 23 : Abstract motif of man and woman.

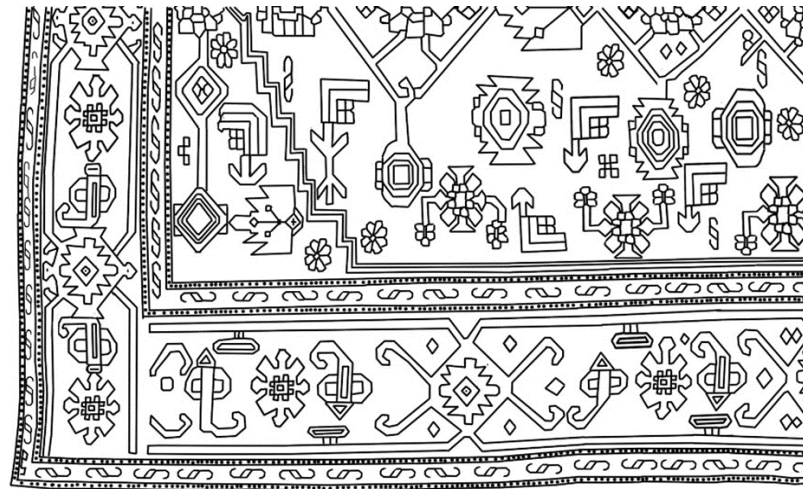


Figure 24 : One-fourth of the pattern.

### 1.3.3. The center of the carpet

This carpet's center is its most significant feature. This carpet's center is shaped like a rhombus. A turquoise pond can be found in the yards of Iranian households. The middle of the object is knotted to resemble a blue pond design (Fig. 25). Among nomads, a rhombus represents protection from the prying eyes of the unkind. They believe that this motif can ward off sore eyes. The pond needs fish. Among Iranian carpets' most prevalent designs is the in and out fish design. They frequently approach couples, circling one another. The designs in the middle of an Iranian carpet are known as a medallion (Fig. 25).

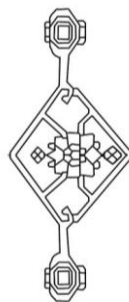


Figure 25 : Medallion (Turanj).

In most Iranian urban carpets, a quarter medallion is put in each of the four corners. And the medallion design corner is complete. However, with nomadic weaving, the



weaver creates the corners with ingenuity, using motifs and colour contrasts. The corners of this carpet were fashioned by the weaver depending on his beliefs or wants (Fig. 26). In nomadic carpets, motif separation and placement in each position depending on number and repetition are also significant.

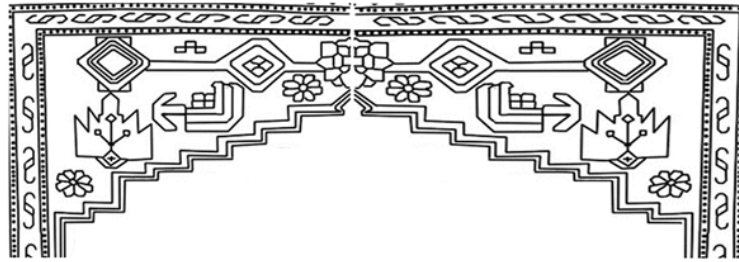


Figure 26 : Moving thin lines to make the border of the carpet.



## 2. Historical tools and materials

The instruments needed to weave a carpet are known as carpet-weaving tools. Although the appearance of these tools may vary depending on the ethnic group they belong to, their use remains the same. There are two groups of these tools: 1. Persian weaving tools: knives, Persian weaving scissors, and combs (Fig. 27).<sup>37</sup> 2. Tabrizi weaving tools: hooks, weft skewers (Fig. 33), combs, and scissors.<sup>38</sup>

The traditional carpet weaving tool in Figure 27 (Persian weaving tools) belongs to the Afshar nomads of Kerman province. In this area, carpets are woven with an asymmetric knot (the Persian knot).

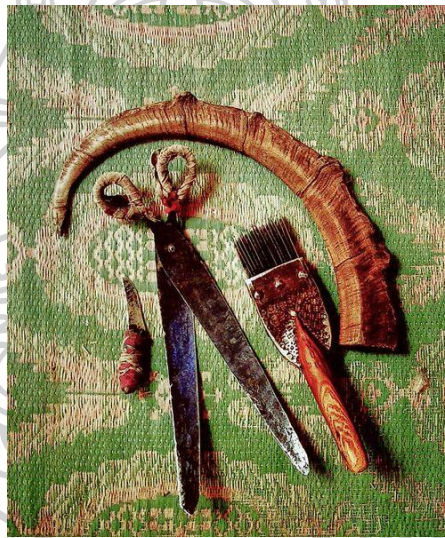


Figure 27 : Weaving tools among the Afshars of Kerman, (Persian weaving tools).

### 2.1.1. Carpet loom

The first thing that comes to mind while discussing hand-woven carpets and the handcrafted equipment of this genuine Iranian art is the carpet loom, as that is the most crucial tool of this manual craft. A carpet loom is employed in other hand-woven crafts.

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<sup>37</sup> Jouleh 2002, 1.

<sup>38</sup> Elahi, Mahbobe. 2008. "Identity of Fish in Iranian Carpet." *Goljaam* 4, no. 10 (September): 101-136. <https://goljaam.icsa.ir/article-1-396-fa.html>

Weavings such as Kilim, Zilu, etc. also use it. There have traditionally been two different kinds of carpet looms: vertical carpet looms and horizontal carpet looms (Fig. 29-32).<sup>39</sup>

Horizontal loom, the earliest style of loom is the horizontal one, although it is no longer used outside of villages, tribes, and nomadic populations in other areas (Fig. 30). The most significant benefit of this kind of loom is that it is portable and easily disassembled, making it simpler to set up and operate for nomads who live in low-lying tents.<sup>40</sup> It also has several downsides. One of its biggest drawbacks is that it takes up a lot of space. Weaving with horizontal looms imposes physically more demanding conditions on the weaver.<sup>41</sup> (Fig. 29).

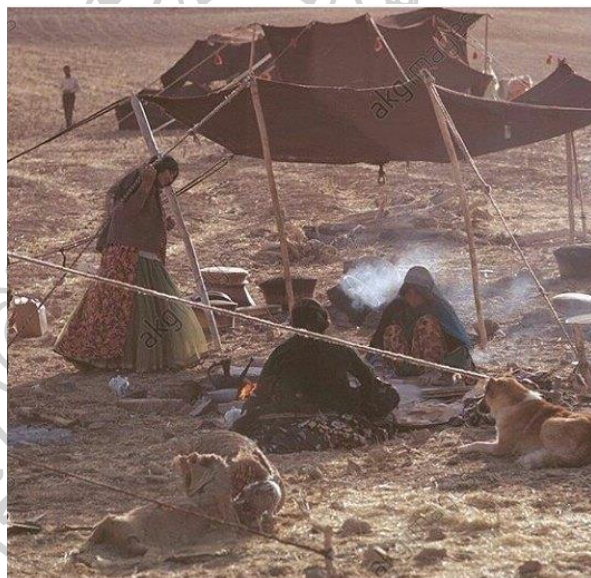


Figure 28 : A picture of nomadic life.

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<sup>39</sup> Allah Dad, Reza, Karam R. Haseli, and Mohammad H. Farjo. 2014. *Carpet Weaving*. Tehran: Iranian Textbook Publishing Company.

<sup>40</sup> Allah Dad, Reza, and Hassan Moradi. 1987. *Carpet Weaving (Handicrafts) First Year of General Secondary Education*. Tehran: Farhang Islamic Publishing House.

<sup>41</sup> Tawafi, Hengame. 2016. *Introduction to Carpet Weaving*. Tehran: Monadi Tarbiat Cultural Institute.





Figure 29 : The method of weaving on the horizontal loom.

The early horizontal looms were made out of merely two sticks positioned above and below the loom. A short distance away, the sticks were fixed to the ground with nails. They were held firmly in place by the corresponding ropes. These looms, like the other goods used by nomads for daily living, (Fig. 28)<sup>42</sup> could be quickly gathered for movement and migration (Fig. 29-30).<sup>43</sup> The woven carpets had more defects during weaving than the vertical looms due to the intermittent displacement and the style of horizontal loom positioning.

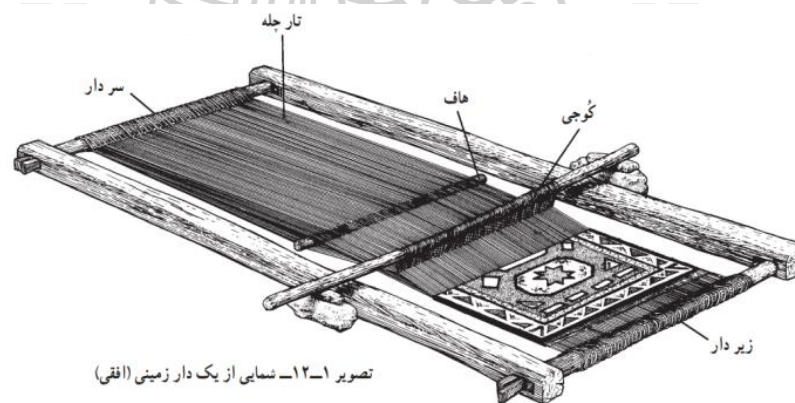


Figure 30 : The horizontal loom.

<sup>42</sup> Mirzaei, Farhad. 2014. "Photos of Life in Qashqai." Tribe Great Qashqai Clan. Accessed March 30, 2023. <https://mirzaie.loxblog.com/post/30>.

<sup>43</sup> Allah Dad, Haseli, and Farjo 2014, 96-97.

Vertical loom, Its positioning during carpet weaving is the primary explanation for its name. The development of this loom can be seen in three different vertical loom variants. 1. A fixed loom that is used to weave large yet delicate carpets; its lower portion is fixed and extends about half a meter into the ground. According to the height of the woven part, the weaver can move the seat to the higher part (Fig. 31). 2. The Tabrizi loom, which makes it possible to change the loom's height while weaving and turning the carpet on it (Fig. 32).<sup>44</sup> 3. A non-fixed loom that permits the lower portion of the carpet to be wrapped; the weaver's location and position are fixed during weaving at tabrizi and non-fixed looms.<sup>45</sup>

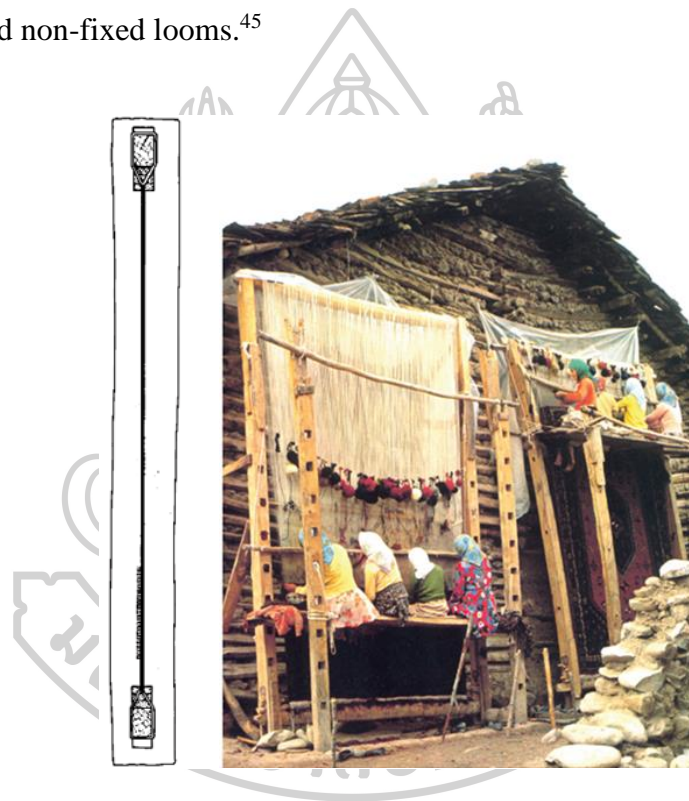


Figure 31 : Vertical loom (A fixed loom).

<sup>44</sup> Allah Dad, Haseli, and Farjo 2014, 97-99.

<sup>45</sup> Farahani, Marzie. 2021. "Types of Carpet Looms and Detailed Knowledge of Their Components and Dimensions." Farahan Carpet. Accessed April 18, 2023. <https://farahancarpet.com/fa/types-of-carpets-loom/>



Figure 32 : Vertical loom (The Tabrizi loom).

### 2.1.2. Knotting hook

A knotting hook is a tool that is similar to a knife but narrows to the point where it becomes a rod between one and two cm long (Fig. 33).<sup>46</sup> The weavers move the thread forward, bind the woolen thread, and then take the thread out of the warps using the hook-like protrusion at the end of this rod. After knotting, the thread is cut off with the hook's knife-edged edge.<sup>47</sup>

### 2.1.3. Polishing scissors

In carpet weaving, there are two categories of scissors to trim long piles: Persian (Fig. 27) and Tabrizi scissors (Fig. 33): the edges of both blades of these scissors are adjustable by the height of the piles. Tabrizi scissors: These scissors have two levels for the blades and handles. This curvature makes the work easier. The improper use of scissors and excessive pruning of carpet piles in each row can cause early abrasions during use.<sup>48</sup>

<sup>46</sup> Allah Dad and Moradi 1987, 45-48.

<sup>47</sup> Samadi Bahrami, Youssef, Nasrullah Taslimi, Abdul Reza Jamali Fard, Reza Safari, Bushari Golbakhsh, and Rahim Foroohar. 2018. *Specialized Technical Knowledge Field of Handicrafts - Carpets*. Tehran: Iran Textbook Publishing Company.

<sup>48</sup> Allah Dad and Moradi 1987, 37-44.

#### 2.1.4. Comb (Daftin)

After a row has been braided, the knots are combed with a metal or wooden comb. Following the weft's passage through the knots, combing is completed. The carpets gain elegance and smoothness by having the knots placed uniformly along the rows. The type of comb used depends on the carpet's density.<sup>49</sup>

#### 2.1.5. Carpet pattern (carpet map)

A carpet pattern is a map produced on graph paper by designers and cartographers. Before creating a carpet map, the necessary carpet density must be established. The design is then produced using the dots and the number of rows (carpet density) on graph paper (Fig. 33).

A braided carpet can occasionally serve as a map. In other places, weaving from the pattern is also typical. The pattern, which was given to the weavers in place of the paper map, is a piece of carpet on which some of the border and background are woven; in other words, it is a quarter of the entire carpet.<sup>50</sup> These types of designs were present in the Hamadan region.



Figure 33 : Tools and materials. a. Tabrizi scissors, b. comb, c. carpet pattern, d. hook.

<sup>49</sup> Yesavali 1991, 17.

<sup>50</sup> Daryaie 2018, 24-31.



## 2.2. Structure and technique

The knots tied on the warp form the foundation of carpet weaving. Although there are some variances in the materials used and the technology used to warp, there are significant differences in the weft counts and knot styles. There are more than twenty different types of knots that each nation uses in weaving and knotting according to its traditions (Fig. 34).<sup>51</sup>

Different regions of Iran use distinct knotting techniques. There are typically two main types of knots used across Iran. The knots are made of wool or silk, which have been dyed in different colours. The quality and durability of the carpet increase with the number of knots on its surface.

The warps must first be stretched vertically on the carpet loom before weaving can begin. The warps and thicknesses to use are specified in the pattern. There are two warps required for each knot. After this, weft threads are laid down in horizontal rows to begin the carpet weaving. Following a few rows, the first row of knots is tied using coloured threads by the pattern. The majority of Hamadan carpets are made with woolen yarns for the knotting and cotton for the warp and weft.

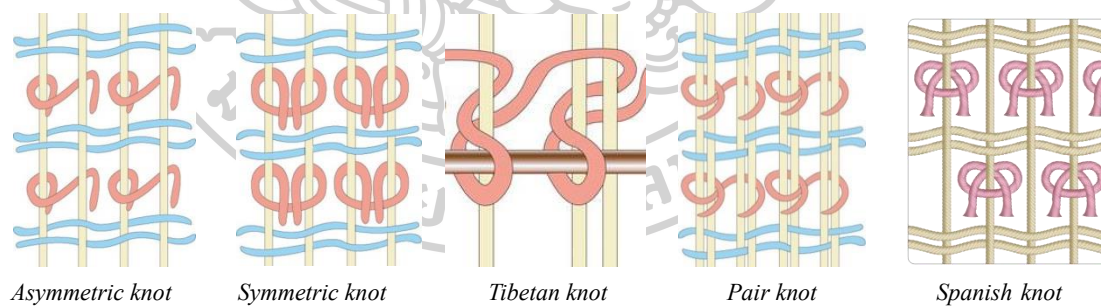


Figure 34 : Variety of knots implemented in Iran and other countries.

<sup>51</sup> Villedomo.com. "Knots per Inch (KPSI)." Accessed August 18, 2023.

<https://villedomo.com/pages/knots-per-inch>



### 2.2.1. Warp, weft yarn

Most frequently, warp and weft are made of cotton. Goat hair is often used in nomadic carpets as warping. Because it is less elastic and keeps its shape better, commercially prepared undyed cotton is typically used in the warps of finer carpets created in commercial workshops.<sup>52</sup>

5, 10, 20, and 32 are common raw yarn grades used in carpet weaving, and ready-to-use spun yarns are named based on the yarn grade and number of spun layers. For instance, a grade 20 thread with 12 layers is known as grade 20-12 layers. In carpet weaving, grade 20 and 32 thread are typically used for thin weft, and grades 5 and 10 thread for thick weft. Thin weft, is mostly used from 20-2 layers to 20-6 layers.

For the thick weft, 5-5 layers to 5-20 layers and 10-55 layers to 10-20 layers are used more. Thick weft and thin weft are usually dyed blue, cream, or red before use, and they are used in harmony with the background colour of the carpet, but the use of blue is more common in most. The weft used in the object is blue.<sup>53</sup>

### 2.2.2. Knotting yarn

Sheep wool has traditionally been the primary material used to weave Iranian carpet knots, while other fibers like silk have also been employed. The primary component of the carpet knots is a yarn spun from wool, and depending on its diameter, it has several grades that are identified and labeled using the metric system.

Symmetric knot, This technique is popular in Azerbaijan and villages around Hamadan. In this type of knot, the woolen yarn is going back from the front and side of the two warps, and then it goes back forward from inside the warps and is tightened. In the Hamadan carpets, 92.9% of the rugs have a symmetrical knot weaved on the thread with or without a hook, while an asymmetric knot is employed in 3.5% of the cases<sup>54</sup> the sort of knot utilised in the object is symmetrical.

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<sup>52</sup> Yesavali 1991, 18.

<sup>53</sup> Allah Dad and Moradi 1987, 27.

<sup>54</sup> Talebpour 2019, 25.

Asymmetric knot, This technique is popular in central cities such as Mashhad and around Tehran. In the Asymmetric knot, the yarn is taken back from the side of the warps and comes out from between the two warps, then goes around the second warp and comes out from between the two warps, then is pulled out and tightened. Figures 35 and 36 show two typical knots used in Iranian carpet weaving.<sup>55</sup>



Figure 35 : Symmetric knot.



Figure 36 : Asymmetric knot.

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<sup>55</sup> Tawafi 2016, 93.

### 3. Technological survey

Identifying the technology of the object as well as the materials used in it is very necessary to determine the methods of protection and restoration. In this chapter, after examining the materials used in the object, the technology of its weaving is identified and explained.

#### 3.1. Carpet yarn

It is required to identify the yarns to determine the materials employed in the object. Microscopy with polarised light<sup>56</sup> is a useful method to obtain information about the molecular structure of fibers and surface features.<sup>57</sup>

##### 3.1.1. Sampling

Samples were taken<sup>58</sup> from areas that didn't compromise the carpet's structural integrity.<sup>59</sup> Dark brown, white, orange, blue, navy blue, light red, red, crimson, light brown, and black portions of the carpet were used to collect samples for the knot and selvage thread. The carpet was documented and photographed before a sample was collected (Fig. 37).



Figure 37 : The woolen yarn samples.

<sup>56</sup> Optical and Polarized microscopes were used to identify the type of fibers.

<sup>57</sup> Houck, Max M., ed. 2009. *Identification of textile fibers*. Virginia: Woodhead Publishing.

<sup>58</sup> The fiber analysis using light and Polarized light microscopy was carried out at the Institute for Conservation and Restoration (head: o. Univ.-Prof. Mag. Dr. Gabriela Krist) in cooperation VL Dipl.-Ing. Dr. rer. nat. Tatjana Bayerová.

<sup>59</sup> On page 106, in Appendix III, to identify the materials used in the object, are sampling details.

Figures 38 to 40 show a more detailed location of the sampling of warp, weft, and thread used in knots and selvage. Using tweezers and scissors, the samples were extracted from the object at the locations shown in Figure 41. The samples were studied and photographed using optical and polarised light microscopy.<sup>60</sup>



Figure 38 : Sampling position of the knot.



Figure 39 : Sampling position of the weft.



Figure 40 : Sampling position of the warp.

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<sup>60</sup> Madlener 2022, 54-55.



Figure 41 : Sampling position of warp, weft, and knot.

### 3.1.2. Polarised light microscopy (PLM)

The ability to portray observations in three dimensions by altering the angle and nature of light radiation is one of the most significant benefits of polarised light microscopy. One technique for thoroughly examining the morphology of old fibers (such as fabric and paper) is polarised light microscopy defining the fibers' characteristics is the first step in developing a conservation strategy.<sup>61</sup> Figures 42–45 show fiber samples taken from the range of warp, weft, and knots analysed under a light and polarised light microscopy.<sup>62</sup>

Figures 42 and 43 depict warp threads, 44 and 45 weft threads, and 46 and 47-knot threads from the ready samples. The samples were originally inspected using a 100x

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<sup>61</sup> Houck 2009, 35-38.

<sup>62</sup> The analysis of particles attached to fibers using the SEM-EDS microscope was carried out at the Institute for Conservation and Restoration (head: o. Univ.-Prof. Mag. Dr. Gabriela Krist) in cooperation with Sen. Lect. Dr. Farkas Pintér



light microscope and subsequently with the polarised light microscope. The samples were compared to laboratory control samples. Cotton filaments were shown in figure 42.

This cotton thread resembles a bean plant. The twist and look of the cotton fiber are also visible under the polarised light microscope (Fig. 43). Many of the characteristics of the weft thread are also present in the warp thread in figures 44 and 45. The warp and weft fibers are made of cotton. Figure 46 displays selvage fibers. Small lines can be seen on wool fibers. Figure 59 provides evidence for these tiny lines existence.<sup>63</sup> A microscopic examination revealed that the warp and weft fibers were cotton, while the threads used to make the knots were made of wool.

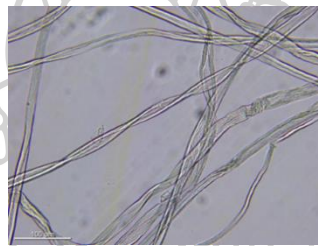


Figure 42 : Cotton fibers, taken from the warp

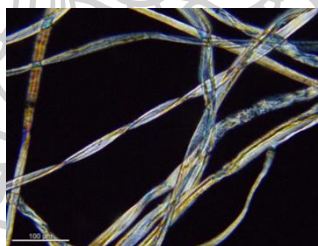


Figure 43 : Warp yarn under a polarised light

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<sup>63</sup> Göllner, Caroline. 2019. "Two Black Pleated Bourgeois Bonnets, 18th Century, from the Innsbruck Folk Art Museum." Diplom, Institute of Conservation, University of Applied Arts Vienna.



Figure 44 : Cotton fibers, taken from the weft yarn.

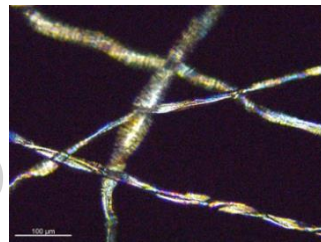


Figure 45 : Weft yarn under polarised light microscopy.

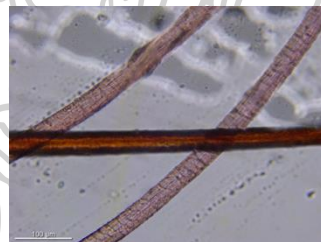


Figure 46 : Wool fibers under the light

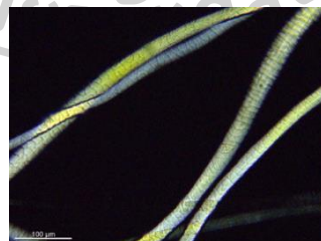


Figure 47 : Wool fibers under polarised light microscopy.

### 3.2. Carpet knotting technology

Conservation work requires a thorough understanding of the technological aspects of historical artifacts. It is crucial because it may enable the conservator to gain a deeper understanding of the historical object. Additionally, it is best to understand where the

defects and damages came from. It might result in a conservation and restoration plan that is more precise. Understanding technology also entails understanding the production processes and materials employed in historical artifacts. It was necessary to reconstruct a portion of the object with identical technical requirements to better comprehend its technology. At the same time, the method of weaving the historical carpet will be studied.

### 3.2.1. Carpet knotting stages

The first step is warping. The warp thread was prepared based on the size and quality of the historical carpet warp threads. 20–12-layer cotton thread was used for warp thread. A 10–8-layer cotton thread was used for the weft thread. For knots, 6-2-layer wool was used. Based on the density of the carpet, the warp threads are drawn on the frame. They prepared for twenty knots every seven centimeters (Fig. 48).



Figure 48 : Warping implementation in 7 cm.



Figure 49 : Implementation of the chain with the wheat form.

There are chains on the historical carpet that implement the same technique on the new threads. To ensure that the weft rows and knots remain firmly in place and do not slip outward, the chain is run through the carpet's initial and last rows. The implementation of the chain is such that the pink thread creates a new loop after spinning behind the warp. In this re-creation, the chain thread was employed in pairs (Fig. 49). The Kilim is then created by running the weft in a zigzag pattern after that (Fig. 50).

A selvage or screw edge is used to reinforce the carpet's longitudinal edges. There are two methods for selvage. The selvage method is applied in the Hamadan carpet concurrently with the row-by-row knotting; as a result, it is based on the method of the selvage examined item at the beginning of the row (Fig. 51).

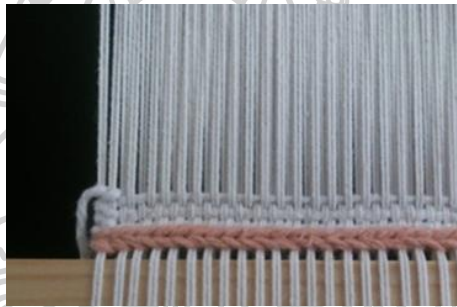


Figure 50 : Implementation of the basic Kilim with weft thread.



Figure 51 : Performing selvage at the same time as knotting.

The symmetrical knot is implemented according to the colour of the wool thread. In this type of knot, the woolen yarn is going back from the front and sides of the two warps, and then it goes back forward from inside the warps and is tightened (Fig. 52-55).



Figure 52 : Passing the woolen thread behind the warp.

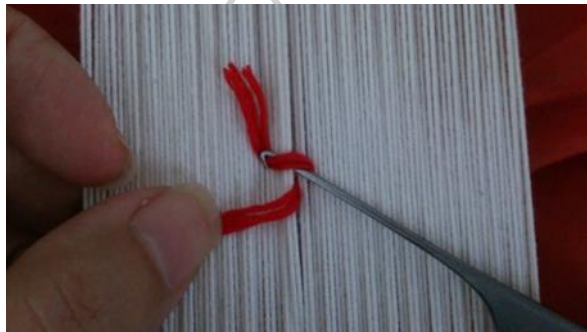


Figure 53 : Creating a loop by turning the woolen thread between two warps.



Figure 54 : Pulling out the head of the knot and completing the knot.





Figure 55 : To pull down the knot to tighten the knot.

Following the completion of the knot rows, the weft thread is completed in each row and strengthened and evened using a metal comb (Fig. 56-58).



Figure 56 : Passing the weft thread over the knots.



Figure 57 : Passing the weft thread over the knots.



Figure 58 : Cutting the ends of the knots by scissors.

The last step of knotting in each row is to scissor the heads of the stems of the knots in the row to have a smooth surface. Before shearing, all the knots should be pulled forward to remove excess lint from between the knots and woolen threads (Fig. 59).



Figure 59 : Carpet surface (front).



Figure 60 : Carpet surface (back).

The Kilim is completed to the extent that was started at the beginning of the carpet. At this point, the carpet is prepared to be cut from the loom. Cutting the warp is a delicate process, and it should be done evenly on both sides at a distance of 12 to 15 cm. The term carpet root refers to the warps that run above and underneath the carpet. The carpet's quality is assurance the yarn with the proper density following the chosen pattern. (Fig. 59-60).

### 3.3. Density

The counting of knots to reveal the delicacy of the handwoven carpet is a traditional method. The identical node contains both points. The density of this carpet is based on 7 cm due to the nature of the threads and knots. The Hamadan carpet under investigation had a density of 20 knots per 7 cm (Fig. 61).

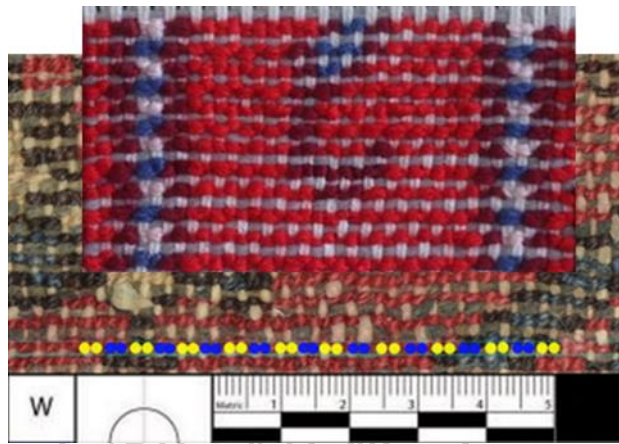


Figure 61 : Matching object density with Mocap.

### 3.4. Dyed yarns

Carpet dyeing is a process in which cotton, wool, and silk are dyed in a solution containing dyes derived from natural or chemical substances. In this process, dye molecules establish a strong bond with fiber molecules. Therefore, the colour of the dyed fibers must have high stability. Except for aesthetic reasons that are important, dyeing materials should be able to be highly resistant to damaging factors such as sunlight, and moisture.

Based on the origin of dyes, they can be grouped into two categories: 1. natural; 2. synthetic. Given that the object dyes are natural, the natural dyeing components will be discussed. The following categories apply to natural dyes, depending on where they are extracted: 1. minerals; 2. materials obtained from animals; and 3. plant materials

(vegetable dyes).<sup>64</sup> Traditionally Persian dyers have used plants (vegetable),<sup>65</sup> animal, and mineral products to produce both dyes and mordants, the agents used to enhance the fibers' capacity to absorb dyes and to fix the colours. Plants dyes were widely used in Iran up to the 1900s.<sup>66</sup>

Ehsan Ekrami documented natural dyeing procedures used in dyeing workshops in Hamadan province for the Iranian National Carpet Center research project. He described the procedures and plant materials used in each hue and recreated each color in laboratory circumstances by gathering written copies from traditional dyeing centers in Hamadan.<sup>67</sup> In her article, Shahdekht Rahimpour also examined the dye plants used in traditional dyeing in Iran's central province.<sup>68</sup>

#### 3.4.1. Red yarn

In general, two animal and plant dyes are used in the production of red. 1. It is obtained from the powder of female insects (*Dactylopius coccus*) and is known as lacquer (*lāk*).<sup>69</sup> Citric acid ( $C_6H_8O_7$ ), which is contained in the juice of sour fruits and citrus fruits, has

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<sup>64</sup> Mirza Amini, Mohammad M., and Hojatollah Reshadi. 2017. *Carpet Production Process*. Tehran: Cheshme.

<sup>65</sup> Mordantes are materials that are used to stabilize and colour more fibers; they create a different colour spectrum, such as copper, white alum, black alum, and acetates of iron.

<sup>66</sup> Khajeh Ahmad Attari, Ali R., Mohammad T. Ashouri, Bijan Arbabi, and Mehdi Keshavarz Afshar. 2015. "The Impact of the West on the Carpets of Qajar Era." *Goljaam* 13, no. 31 (August): 5-20.

<sup>67</sup> Ekrami, Ehsan. 2012. director. "Documentation of Natural Dyeing Methods in Dyeing Workshops in Designated Areas of Iran (Central and Hamadan Provinces)." *Academic Jihad Scientific Information Center database*. no. 1 (September): 301-316.

<sup>68</sup> Rahimpour, Shahdokht. 2018. "Identification of Carpet Dyeing Traditions and Analysis of Dyeing Situation in Markazi Province." *Journal of Apparel and Textile Science and Technology* 8, no. 1 (March): 21-29. [https://www.jtst.ir/article\\_103630.html?lang=en](https://www.jtst.ir/article_103630.html?lang=en)

<sup>69</sup> Lombard, Maurice. 2002. *Les Textiles Musulmans Du VIIe Au XIIIe Siècle*. 2nd ed. Paris and The Hague: EHESS.



been used to induce colour changes in *Coccus lacca* due to their sensitivity to pH fluctuations, which cause colour changes.<sup>70</sup>

2. Dyestuff extracted from the root of *Madderr* (*Rubia tinctorum*), which is historically the most important dyestuff in Iran. (*rūnās/rūnīās*). The age of the plant, the quality of the fibers, and the compounds added in the dyeing stage (like dried yogurt (*dūḡ*) and the juice of sour grapes along with the dye) make it possible to create a wide range of shades and red tones.<sup>71</sup> Sour natural substances, like lemon juice, have been employed in traditional dyeing to produce colour changes since ancient times. For instance, the light red hue is created by laying the dyed wool in buttermilk (sour yogurt)<sup>72</sup>, which contains lactic acid (Fig. 62-64).



Figure 62 : light red knotting in the corners of the carpet.

<sup>70</sup> Behpouria, Amin, Siyamak Safapour, and Mousa Sadeghi-Kiakhanic. 2016. "Study on the Effect of Citric Acid Addition on Colour Characteristics of Woolen Yarn Dyed with Cochineal Dye." *Iran's First Applied Chemistry Seminar, Faculty of Chemistry, Tabriz University*.

<sup>71</sup> Oktaei, Nasser. 1984. *The Art of Dyeing with Plants*. Tehran: Self-sufficient Publishing House.

<sup>72</sup> Hayati, Mehdi. 2014. *Dyeing Fibers with Natural Colours*. Tehran: Publishing Jihad Kashwarzi.



Figure 63 : Different shades of red.



Figure 64 : Different shades of red in the line of the motif.

### 3.4.2. Blue, navy blue yarn

The indigo plant's (*Indigofera tinctoria*) fermented leaves are used to make blue and navy. One of the primary colours used to create blue and green is indigo.<sup>73</sup> On cotton, indigo results in deep and dark blue colours.<sup>74</sup> Violet colour is made by adding indigo

<sup>73</sup> Eranicaonline.org. 2023. "Raw Materials and Dyes." EncyclopæDia Iranica. Accesed January 11, 2023. <https://www.iranicaonline.org/articles/carpets-ii>

<sup>74</sup> Soaresrafil, Shirin. 1999. *Iranian Colors*. Tehran: Handwoven Carpet Research Institute.

to dyestuff extracted from the root of *Rubia tinctorum*.<sup>75</sup> The blue colour is also obtained from the *Isatis tinctoria* plant.<sup>76</sup> (Fig. 65-67).



Figure 65 : blue in the motif of dancing flowers.



Figure 66 : light blue in the fish motif.



<sup>75</sup> Khosravi, Alireza, Kamaluddin Qaranjig, and Mojgan Hosseinejad. 2010. *Dyeing of Synthetic Fibers and Cellulose Acetate*. Publisher: Academic Jihad, Amir Kabir Unit.

<sup>76</sup> Charsino.com. 2022. "Dyeing of Wool Fibers in Iran." Online Handicraft and Art Market. Accessed February 8, 2023. <https://charsino.com/dyeing-wool-fibers/>

Figure 67 : Opaque blue in the leaf motif.

### 3.4.3. Brown yarn

Walnut shell produces camel, brown, and cream colours;<sup>77</sup> (Fig. 68) When combined with black alum, it produces a black colour. In Lorestan region, oak bark is used for brown dyeing.<sup>78</sup> However, the weavers of many nomadic carpets may have used only threads woven from sheep's wool to knot the entire carpet. Because they haven't been dyed, these yarns have the natural colour variety of sheep's wool. They are various shades of white, cream, gray, light to dark brown, and black (Fig. 69). The weaver used natural-coloured thread for the fish motif parts. The weaver did not use blue for the motif colour (Fig. 66) In one part of the carpet, the colour of the fish is light brown and cream. and wool with the original colour (sheep) is used (Fig. 69).



Figure 68 : Dark and light brown in the fish motif.



Figure 69 : Using natural wool colours.

<sup>77</sup> Fibercurious.com. 2023. "How to Make Walnut Dye." Accessed January 2, 2023. <https://fibercurious.com/how-to-make-walnut-dye/>

<sup>78</sup> Allah Dad and Moradi 1987, 20-21.



Figure 70 : Variation of brown colour in the motif of crab.

#### 3.4.4. Yellow, orange, green yarn

*Reseda (Spark)*: Is a plant that can be found in all parts of Iran. With its colour, all kinds of yellow colours are obtained.<sup>79</sup> This plant grows on its own, and its flowers have the most colour and its roots have the least colour. Indigo and plant powder, (*Prangos ferulacea*), are boiled together to obtain wool of a green colour. Grape leaves are used to produce the yellow colour. For a dark golden hue, dried and ground pomegranate peels are employed. (*Rubia tinctorum*) and (*Reseda*) are used to create an orange tint.<sup>80</sup> Various tonalities of orange are knotted into carpet motifs. This colour is used on small sections. They are like dots or lines all over the carpet (Fig. 71-72).



Figure 71 : Orange in flower motif.



<sup>79</sup> Edwards, Arthur C. 1953. *The Persian Carpet. A Survey of the Carpet-Weaving Industry of Persia*. London: Gerald Duckworth & Co., Limited, London UK.

<sup>80</sup> Rahimpour 2018, 21-29.



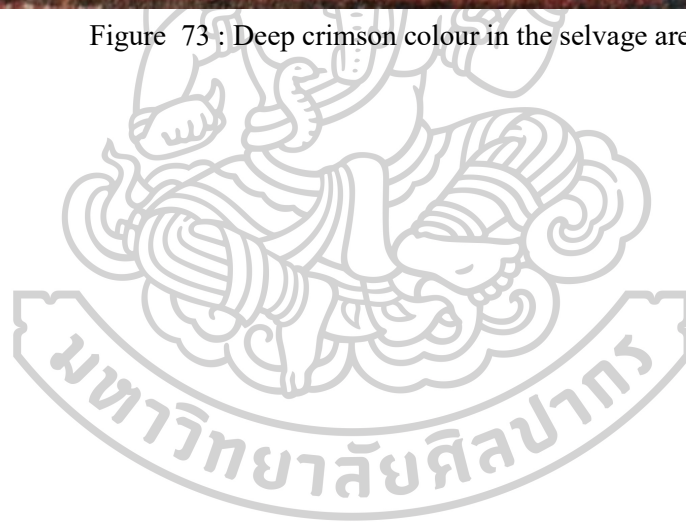
Figure 72 : Pale orange in fish motif.

### 3.4.5. Purple and crimson yarn

When combined with iron sulfate (*Rhus*),<sup>81</sup> produces a dark purple-brown tint. For purple and crimson hues, logwood (*Haematoxylum Campechianum*) is employed.<sup>82</sup> The weaver has also used dark crimson or brown-toned threads in some rows. Crimson is in the selvage section. It displays a highly reflective colour with shades ranging from purple to brown (Fig. 73).



Figure 73 : Deep crimson colour in the selvage area.



<sup>81</sup> On page 105, in Appendix II, are plants used in the traditional dyeing of fibers in Iranian carpets.

<sup>82</sup> Allah Dad and Moradi 1987, 20-21.

#### 4. Condition survey

Concern over carpet conservation and restoration for display and durability was raised at the same time, and it has continued to be crucial ever since. Over the years, carpets have been damaged, and occasionally destroyed. Restorations, however, have frequently failed due to a lack of knowledge about the technology or different types of defects and damage.

Most of the researchers who have investigated the damage to Iranian carpets have classified the damages based on the intensity of their destruction. Researchers classified damages<sup>83</sup> into first, second, and third classes:<sup>84</sup> (1) minor damage, including surface stains, tears, selvage damage, and minor root loss; (2) moderate damage, such as abrasions and minor tears; and (3) severe damage, such as carpet burns, tears, and rot.<sup>85</sup>

##### 4.1. Defects during the knotting-process

Defects are irreparable because they are a product of the history, culture, and philosophy that went into making the object.<sup>86</sup> It is crucial to distinguish between them since the conservator may encounter challenges if they are occasionally seen as damages.<sup>87</sup> To be able to develop a suitable concept of conservation and restoration, defects from the knitting process and damages that occurred later have to be distinguished.<sup>88</sup>

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<sup>83</sup> Jouleh 2002, 147.

<sup>84</sup> In a scientific research article, Shandiz and colleagues sought to address the issue of defects and damaged surfaces in more detail in the study they presented on the new stratification. Object damages are assessed and classified in the following sections based on the type of damage.

<sup>85</sup> Eftekhari Rad, Fariba. 2012. *Carpet Restoration Special Technology*. Tehran: Dolatmand Publishing.

<sup>86</sup> In most of the recent literature, the causes of defects are categorized solely by how defects or adverse environmental conditions affect them. The purpose of this grouping is to demonstrate the various kinds of defects that can be found in a historical carpet. In Najma Zare's book, *Carpet Weaving: The Second and Third Years of Vocational High School*, two defects are explained, elevating and indenting the edges of the carpet. In his textbook, *Restoration of Carpets and Rugs*, Bijan Arbabi has discussed the damage to carpets and their restoration. He has explained the defects during weaving, such as the weft thread head, and their repair methods.

<sup>87</sup> Zare 2013, 111-170.

<sup>88</sup> Arbabi, Bijan. 2008. *Restoration of Carpets and Rugs, Published*. Tehran: Tehran University of Arts.

The most important source dealing with defects in carpets is Torreh, the Persian Handmade Carpet Journal. Hamid Kargar has explained common mistakes in weaving in a series of articles, such as (Abrashi), Carpet creases and wrinkles (Cisi), two colour tones, and Sword (Shamshiri).<sup>89</sup>

There are many different causes of defects. The incorrect or careless selection of raw materials is one of the most frequent causes of defects during the weaving process or even after weaving.<sup>90</sup> Historical carpets have been woven using natural fibers like cotton, animal fibers like wool, silk, and hair, and on occasion, metal fibers like gold and silver. For weaving, the fibers must be specially processed. Defects in weaving can result from the weaver's improper selection of these fibers and defects in preparing them according to specified standards. Spinning, dyeing, weaving methods, and weaving instruments can decrease the quality of carpets. These cases are about the lack of skills of the weaver in general. The eight most important are described in the paragraphs that follow.

#### 4.1.1. Abrash

Abrash is one of the defects of the carpet. Instead of a uniform base colour throughout, it exhibits colours in a variety of similar tones. The product from each dye pot must be processed and packaged separately after dyeing, as there may be differences in the combination or amount of dyes, the number of mordants, or the stability of the washing in different dyeing pots. Abrash is considered an esthetic feature rather than a defect in many carpets from rural and nomadic. But it is a significant detriment in the urban

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<sup>89</sup> Kargar, Hamid. 2013. "Shamshiri." *TORREH, Persian Handmade Carpet Journal* 4, no. 39 (December): 39.

<sup>90</sup> Tousian Shandiz, Gholamreza, Amirhossein Chitsazian, Mehrnaz Azadi, and Fathali Ghashghaeefar. 2014. "Pathology and Classification of Iranian Carpet Damages." *Goljaam* 9, no. 24 (December): 55-70. <http://goljaam.icsa.ir/article-1-495-fa.html>.

context.<sup>91</sup> Since the historical carpet is generally an Abrash, it can be a variant of Abrash (Fig. 74).<sup>92</sup>

To weave in the nomadic context, due to the lack of control over the dyeing and, as well as the economic situation of the family, the weaver chose dyes available to his family or those that were easily accessible during the carpet weaving phases. Abrash is present in each of the figures. Conservators should pay close attention to the dominant colour and the arrangement of colours at each knot in a damaged area when selecting colours to repair defects or holes in Abrash carpets. A mistake in this step can cause a shading of the restored part (Fig. 75-76).



Figure 74 : Abrash.



Figure 75 : Abrash on the border of the carpet.

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<sup>91</sup> Breck, Joseph, and Morris Frances . 1923. *MetPublications, The James F. Ballard Collection of Oriental Rugs*. New York: THE MET.

<sup>92</sup> Kargar, Hamid. 2013. "Abrash." *TORREH, Persian Handmade Carpet Journal* 3, no. 12 (September): 43.



Figure 76 : Abrash on the background.

#### 4.1.2. Wrong knotting

Wrong knotting can cause the woven pattern or motifs of the carpet to deform.<sup>93</sup> When incorrect colours are chosen for the motifs that can also be considered as wrong knotting.<sup>94</sup> This occurred many times on this carpet. However, the main reason is that the weaver changed a considerable part of the carpet's design as weaver saw fit. Such changes are typical for nomadic carpets. The main reason was that the weaver used the design of the knotted pattern (Fig. 18) as a template rather than the carpet map. Depending on the circumstances and the materials available, the nomadic weaver adjusted the carpet. To make it longer, weaver widened some of the motifs. Also, due to the lack of materials, some motifs were replaced with other colours (Fig. 77).



Figure 77 : The center line, Abrash, the non-symmetry of patterns and motifs.

<sup>93</sup> Jouleh 2002, 123.

<sup>94</sup> Kargar, Hamid. 2015. "Two color tones." *TORREH, Persian Handmade Carpet Journal*, no. 11 (October): 64. [https://fa.wikirug.org/images/7/7a/Carpet\\_Defects\\_12-Hamid\\_Kargar-WikiRug.jpg](https://fa.wikirug.org/images/7/7a/Carpet_Defects_12-Hamid_Kargar-WikiRug.jpg).



#### 4.1.3. Carpet creases and wrinkles (Cisi)

These are bumps on the carpet surface. The creased area stands out from the others because of this defect.<sup>95</sup> The edge is visible within a radius of 10 cm. One side of the carpet that has creases is shorter than the other due to a defect that occurred during the weaving.<sup>96</sup> An excessive number of comb strokes in a relatively small area cause the section to be over-integrated. Other sections on the back of the carpet show that the knoter has increased the density in some areas by vigorously beating the comb (Fig. 78-80). An excessive number of comb strokes in a relatively small area and repeated washing have resulted in the creased appearance of this carpet.<sup>97</sup> Figure 78 shows the wrinkling of the carpet.

This defect caused damage to the selvage. This area has more abrasion since it has been more exposed to walking Fig 79. shows a distance between the two sections of about 10 cm. comparing these two photos with Fig 80, it is clear that the weaver stretched the weft thread in several loose rows before and after this area.



Figure 78 : Wrinkles in the selvage part of the carpet (Cisi).

<sup>95</sup> Stone, Peter F. 1997. *The Oriental Rug Lexicon*. Washington: Univ of Washington Pr.

<sup>96</sup> Kargar, Hamid. 2015. "Cisi." *TORREH, Persian Handmade Carpet Journal*, no. 7&8 (October): 36.

<sup>97</sup> Madlener, Pia L. 2022. "Two Turkmen Tent Band Fragments Inventory and Creation of a Plan of Measures and Presentation Concept and Restoration of One of the Fragments." Diplom., Institute of Conservation, University of Applied Arts Vienna.



Figure 79 : Different-coloured knots in the Cisi area.



Figure 80 : Loose weft at the start and finish of the Cisi.

#### 4.1.4. Two colour tones

Two colour tones occasionally, the colour tone of a section of the carpet deviates from the rest. According to Kargar,<sup>98</sup> this deviation can be anywhere between one centimeter and half the carpet's size.

This carpet has wide sections woven in two different colour tones. The background colour of the red carpet has two colour tones visible, which is likely a result of the dyeing conditions, the nomads' living circumstances, and the frequent transportation. Nomadic weavings are susceptible to the passage of time; this is a typical problem, and weaving would occasionally stop for one to three years before starting again.<sup>99</sup>

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<sup>98</sup> Kargar 2015, 15.

<sup>99</sup> Madlener 2022 , p. 88.

However, the most significant aspect of this carpet is the use of wool, which is naturally dark and light brown. Considering that the yarn ran out during the weaving process, it is clear that the weaver did not have access to all the colours throughout the year and instead used the wool that he had spun in its natural colour (Fig. 81).



Figure 81 : Defects of the weft head and two colour tones.

#### 4.1.5. Weft head

This defect is caused when the head or end of the weft thread comes out from between the warps. The weaver should start the next weft in the same place as the previous weft and place the end of the weft between the warps while knotting. After the carpet is finished, the thick or thin weft threads that are released during the weaving process or are not inserted between the threads during the finishing procedure, poke their heads out from the surface. They become visible on it.<sup>100</sup> The head of the weft thread appears between the motifs as white dots. They produce different abrasion resistance in their area, as the knotted thread (wool) and the weft thread (cotton) differ in their grade of abrasion resistance (Fig. 81).

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<sup>100</sup> Arbabi 2008, 56-63.



Figure 82 : Indentation of the carpet's edges.

#### 4.1.6. Elevating

The term “balazadegi” means that the weavers intentionally or unintentionally increase the main dimensions of the carpet so that it appears longer than usual.<sup>101</sup> The first row, where the historical carpet started, needs to be diagnosed to recognise “Elevating” in

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<sup>101</sup> Jouleh 2002, 125.

the first place. The motifs in the second part of the carpet appear bigger, like the rhombus and flower patterns.<sup>102</sup> To increase the size or length of this historical carpet, the weaver has added rows in the second half of it. The reason for the lengthening carpet includes adding new rows (Fig. 83).

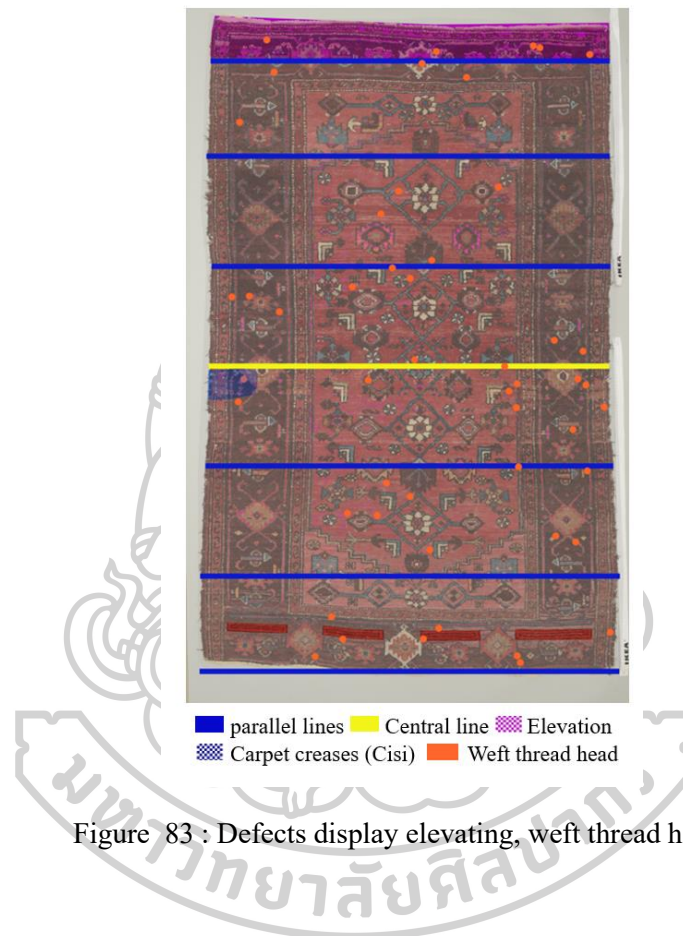


Figure 83 : Defects display elevating, weft thread head.

#### 4.1.7. Sword condition

The transformation of the transverse lines (roots) of the carpet into a curved shape with a bulge or depression is called being a sword.<sup>103</sup> The curvature of it is most noticeable at the bottom or top. A weak or crooked frame at the beginning of the carpet knotting

<sup>102</sup> Zare 2013, 113.

<sup>103</sup> The some of terms are Persian source equivalents. The titles correspond to the translation in English.



process can lead to the development of this defect.<sup>104</sup> The weaver's inability to control the knotting phase has also exacerbated this defect. As a result of inconsistent combing in the upper rows, a sword-like form can be seen in one corner of this historical carpet (Fig 84).



Figure 84 : Defects display carpet edges and colour changes.

#### 4.1.8. Indentation of the carpets edges

The edges (selvage) appear to be pressed in the shape of a curve. This curvature is most visible in the longitudinal section edges of the carpet. When two sides are folded from the selvage side and placed on top of each other, it is possible to see if they are deformed, pressed, or protruding in the length of the carpet (Fig. 82). These defects are

<sup>104</sup> Kargar 2013, 39.

most common in selvages from the central regions of Iran. In this region, the weft thread is wrapped around selvages and transferred to the following row. This defect occurs when the weft thread is pulled too tightly or comes loose during combing. In Tabriz carpets, the thick weft thread is looped around the loom in each row, so this defect is not visible on the side of the carpet until the project is completed. In these carpets, the selvage is woven separately and then sewn together at the edges.<sup>105</sup> The object selvage has been weaved simultaneously with the rows and knots. Indentation of the carpet's edges was caused by the weaver pulling too hard on the weft thread, and the warp threads on the side of the rug were too loose.<sup>106</sup>

#### 4.1.9. Allocation the defects

Table 1 shows the influence of the individual components (warp, weft, and knot) on the formation of individual defects. Based on the material and execution defects, the weft caused most of them. In other words, the weaver did not use the weft with due care. In addition, the weaver has changed the weaving management by inserting new rows. Other defects have been caused by lifting or adding new rows. Weaving defects can occur when the weaver does not follow the pattern in parts, such as two shades of color, sabers, cuts at the edges of the carpet, or differences in the scale of the motifs (Figures 83-84). There are also four small rectangular frames in the lower section of the object that are not woven parallel in the upper part. They are highlighted in red. To indicate the coordinates of the carpet, blue and yellow auxiliary lines were made.

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<sup>105</sup> Zare 2013, 119.

<sup>106</sup> Stone 1997, 205-292.

Table 1 : The eight defects on the components of the carpet.

| Kind of defect                    | Reason  | Warp | Weft | Knot |
|-----------------------------------|---|------|------|------|
| Abrashi                           | Lack of access to homogeneous materials                   |      |      | +    |
| Creases in carpet                 | Uncoordinated combing                                     | +    | +    |      |
| Wrong knotting                    | Asymmetry of motifs and incorrect change of motifs colour |      |      | +    |
| Two colour tones                  | Lack of access to homogeneous materials                   |      |      | +    |
| Elevating                         | Adding undefined rows                                     | +    | +    | +    |
| Sword                             | Uncoordinated comb tapping in higher rows                 |      | +    |      |
| Indentation of the carpet's edges | Pulling the weft thread too much or loosening it          |      | +    |      |
| Weft thread head                  | Letting go of the weft                                    |      | +    |      |
| Total defects                     |   | 2    | 5    | 4    |

#### 4.2. Damages to the object

The usage of carpets and the brittleness of their components (wool, cotton, silk, etc.) have caused most of the damage to object. Knowing the essential distinctions between the different types of carpet damage, such as tears, burns, rot, insect infestation, etc., allows the conservator to make an informed decision about the best methods to protect carpets. One of the most important causes of these types of damage is the effect of environmental conditions on the carpet. Sulfur dioxide, nitrogen oxides, ozone, hydrogen sulfide, soot, and dust are just a few examples of air pollutants that are regularly found indoors and can pose a major threat to carpets. These gases cause corrosion, decomposition and mechanical changes through colour change and acid transfer.<sup>107</sup> Clothes moths, in particular, can thrive in high-humidity environments,

<sup>107</sup> Shelley, Marjorie. 1987. *The Care & Handling of Art Objects: Practices in the Metropolitan Museum of Art, Antiques & Collectibles. The Effect of Light on the Tensile Strength of Museum.* New York: The Metropolitan Museum of Art.

such as the back of the carpet.<sup>108</sup> If moisture and heat are not kept under control, carpets can suffer significant damage.<sup>109</sup>

#### 4.2.1. Pest infestation

Insects have attacked the historical carpet that was being researched. In the process, they damaged a part of it (Fig. 85). Insects have eaten some of the stems of the carpet knots. There were numerous insect eggs within the knots, as was discovered after closer inspection. Figure 86 shows a circle of red wool knots, but it is obvious that the stems are missing. The cotton weft thread is gray, while the cotton warp thread is white.

Three species of carpet beetles cause severe damage to textiles and carpets: the common carpet beetle (*Anthrenus verbasci*), the furniture beetle (*Anthrenus flavipes*), and the black carpet beetle (*Attagenus unicolour*) (Table 2). All three carpet beetle species have similar life cycles.<sup>110</sup>



Figure 85 : Insect attack area.

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<sup>108</sup> For example, wool, one of the most important components of carpet, is susceptible to insect growth and destruction in high-temperature and high-humidity environments. The preservation of carpets also depends heavily on other environmental factors.

<sup>109</sup> Seif, Mohammed H. 2017. "Some Important Recommendations about Preservation and Maintenance Handwoven Carpet at Home or Public Places." *Farshnameh, Journal of the Carpet Sellers Union Handmade in Tehran*, no. 30 (March): 30-45.

<sup>110</sup> Dellinger, Theresa A., Diagnostician, Day, and Eric Day. 2022. "Carpet Beetles." Virginia Cooperative Extension. Accessed January 28, 2023.

[https://www.pubs.ext.vt.edu/content/pubs\\_ext\\_vt\\_edu/en/3104/3104-1588/3104-1588-web.html](https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/3104/3104-1588/3104-1588-web.html)



Figure 86 : Damage to the knot stems and remaining knot rings.

Food sources include furs and woolens. On these, they lay their eggs. The larvae emerge from the eggs after around 15 days at a temperature of 25–26 °C and begin feeding the carpet stems. They prefer dark areas, like behind carpets and in between knots. As a result, this kind of damage appears after the carpet's many components have been destroyed.<sup>111</sup>

(*Periplaneta Americana*), the mouse (*Lepisma saccharina*), carpet beetles, clothes moths, and (*Attgenus piceus*) are considered the insects most likely to damage historically significant carpets.<sup>112</sup> But carpet moths (*Tineola bisselliella*) are responsible for most animal damage to carpets. The moth consumes the keratin in the wool fibers, resulting in the loss of wool-containing carpet fibers.<sup>113</sup>

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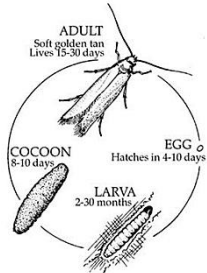
<sup>111</sup> Choe, Dong-Hwan. 2020. "Carpet Beetles." University of California, Agriculture and Natural Resources. Accessed March 28, 2023. <https://ipm.ucanr.edu/PMG/PESTNOTES/pn7436.html>.

<sup>112</sup> Stone 1997, 70-292.

<sup>113</sup> Stone 1997, 70.



Table 2 : The carpet moth and three species of carpet beetle damage (Choe, 2017) and (Basuk, 2018).<sup>114</sup>

|  | Varied Carpet Beetle |       | Furniture Carpet Beetle |       | Black Carpet Beetle |       |
|---|----------------------|-------|-------------------------|-------|---------------------|-------|
|   | Adult                | Larva | Adult                   | Larva | Adult               | Larva |
| Number days for larval stage  | 220–630              |       | 70–94                   |       | 166–330             |       |

#### 4.2.2. Abrasion

A carpet's pile can be damaged by several things, including frequent human movement. While this carpet does exhibit damage from heavy use, a significant amount of this is typical. The extent of this damage can be seen in Figure 94. The knots in this section are approaching the grain<sup>115</sup> formation stage. Abrasion typically occurs more frequently in border areas.<sup>116</sup> The rate of abrasion is influenced by fiber diameter. As fiber diameter increases, carpet density decreases, and abrasion increases.<sup>117</sup>

#### 4.2.3. Tearing

Several tears, which can be brought on by a number of causes, are frequently seen in old carpets. However, historically, both material deterioration and extremely high

<sup>114</sup> Basuk, Mayur , and Jagadananda Behera. 2018. "A Review on Woolen Cloth's Moth and Its Remedies ..." *Textile Today*. Wool Research Association-Center Of Excellence For Sportech, Thane- 400607, Maharashtra, India, (March). <https://www.textiletoday.com.bd/review-woolen-cloths-moth-remedies>.

<sup>115</sup> Corning is a stage of abrasion on the carpet's surface in which the knot loses its stems and each knot is seen without pile and squarely on the carpet's surface.

<sup>116</sup> Madlener 2022, 90.

<sup>117</sup> Shakyawara, D B., N P. Gupta, P C. Patni, and R K. Arora. 2008. "Computer-aided Statistical Module for Hand-knotted Carpets." *Indian Journal of Fibre & Textile Research*. no. 33 (March): 405-410.

mechanical stress may have contributed to significant carpet tearing. Other factors that can accelerate the tearing process include aging or material wear. The scales of wool are severely damaged in this process, as are the fragility of cotton and the decomposition of silk.<sup>118</sup> In addition, the word tearing can be used to describe several other phenomena, including tearing in weft, warp, and weft. Based on the resistance of the carpet or the destructive element, these types of tearing can be divided into several categories. The weft thread of the historical carpet is damaged, so the warp thread could come off. The weft threads in the corners and part of the background of this carpet are torn. The warp thread has been exposed in some places by the longitudinal tears in the weft thread (Fig 89). The size of the tears, which vary between one and seven centimeters, is shown in red in the graphic.

#### **4.2.4. Brittleness or pulverization of fibers**

Chemical decay is an important factor in fiber brittleness or pulverization. The type of dye or mordant used can negatively affect the colours or fibers over time. For example, brown-dyed wool with iron complex will cause colour deterioration or fading.<sup>119</sup> The use of regenerating chemicals in washing is the main cause of this damage.

The threads surface-level and unstable colours are lost during the washing process and may be transferred to other components. Commercial businesses utilise sodium hydrosulfide ( $\text{Na}_2\text{O}_4\text{S}_2$ ) or sodium dithionite solutions to address this issue. The next step is to utilise calcium hypochlorite ( $\text{Ca}(\text{OCl})_2$ ) to lessen friction by applying a chlorine reaction to the surface of wool scales.<sup>120</sup>

Due to rapid regeneration, hydrosulfite residues left in the carpet can cause the fibers to become brittle or crushed. When the carpet is rubbed, it comes out of the pile as a white powder if it has not been thoroughly cleaned. Chlorine is occasionally used in washing carpets to lighten the colour, soften the wool, and improve the shine. Chlorine

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<sup>118</sup> Madlene 2022, 84.

<sup>119</sup> Madlener 2022, 85.

<sup>120</sup> Talebpour, Faridah. 2008. "Effect of Carpet Washing on Woolen Pile Yarn." *Pajouhesh & Sazandegi*, no. 4 (May): 2-7.

can damage and embrittle carpet fibers, especially in older carpets.<sup>121</sup> Shredded lint has accumulated under the historic carpet. More lint falls off the carpet with each movement (Fig. 87).



Figure 87 : Separated fiber powder on the back of the carpet.

#### 4.2.5. Loss of roots

After the weaving process is completed and the rug is removed from the loom, the warp threads of the rug are cut. The warp threads cut at the top and bottom of the carpet are called roots<sup>122</sup> (Fig. 88). Damage to the roots may be the first sign of damage to the warp, which may then lead to damage to the warp itself and eventually to damage to the row of knots. The roots of the carpet are among its most vulnerable parts and are more easily damaged than other parts.<sup>123</sup> Because rug roots are often cream or white, they are more susceptible to staining and damage. The roots of this rug have been significantly damaged, and several fragments have been lost or torn. The cotton roots of this rug have been damaged by constant foot traffic, and the roots that have survived here are relatively weak. In several places, heavy abrasion has damaged the carpet warp. Numerous knots are slipping out of the first row of carpet because the carpet has no side border (kilim). In other words, once the roots reach the warp section, the knots

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<sup>121</sup> Stone 1997, 128.

<sup>122</sup> Arbabi 2008, 102.

<sup>123</sup> The last part of the rug, called the root, consists of threads that are all the same size and can be seen on two sides of the rug. They can be woven in a variety of styles, such as plain, lace, warp, or knotted, and the strength varies depending on the weaving method.

come loose (Fig. 88). There is a possibility that the knots in the first row will come off the warp threads.<sup>124</sup>

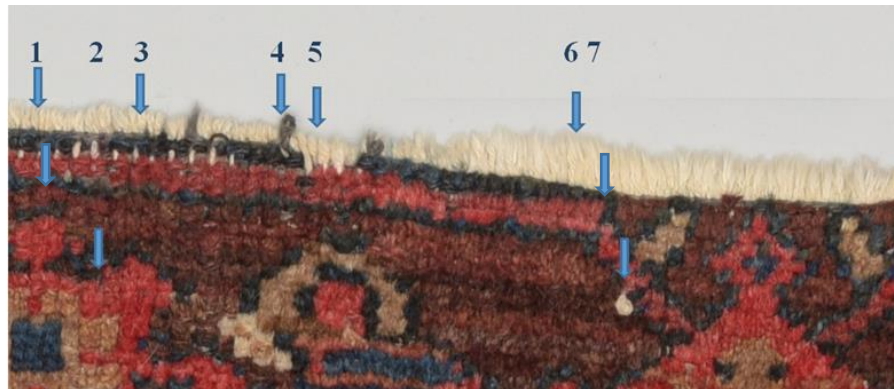


Figure 88 : 1. Loss of roots 2. Corn 3. Knots slipping of the first row  
4. Opening the knot 5. Loss of knots 6. Loss of chain 7. Weft thread head.

#### 4.2.6. Incorrect restoration

Any section of the carpet can receive incorrect restoration, but the patch is one of the most common. The damage of area is occasionally patched with another piece of carpet by restorers unfamiliar with technique, design, and carpet restoration.<sup>125</sup> Because of its relatively good condition, this historic rug did not undergo extensive restoration. Instead, the restorer has attempted to conceal the white of the warp thread between the knots in the torn areas by wrapping it with coloured threads (Fig. 89).



Figure 89 : Incorrect restoration on the warps (torn part of the wefts).

<sup>124</sup> Madlener 2022, 87.

<sup>125</sup> Stone 1997, 362.

#### 4.2.7. Loosening of the carpet

Due to washing, the components of the carpet gradually lose their strength and stability and become softer and more cloth-like. The carpet is covered with what looks like detergent residue and is white and powdery. The carpet still has a sturdy pile, but it is now loose and folds like fabric. The looseness of the carpet may indicate further damage.<sup>126</sup>

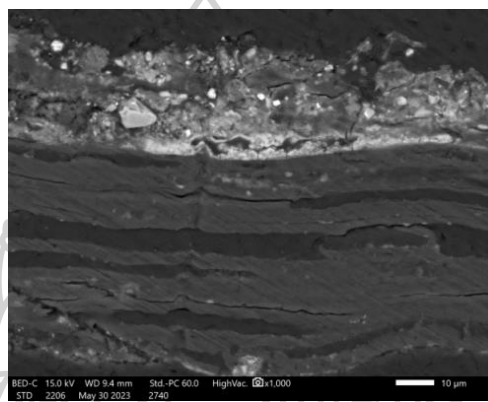


Figure 90 : SEM-Analysis; Backscattered electron image. Detection of white materials.

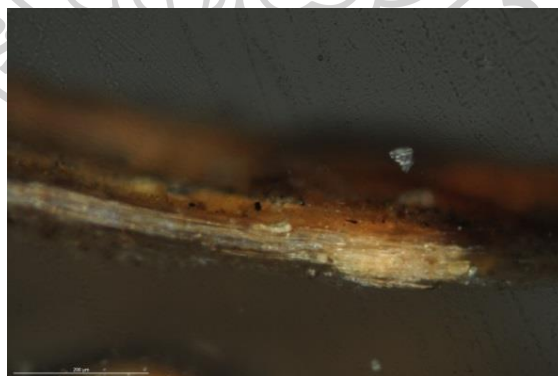


Figure 91 : Cross-section of the white matter inside the knots.

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<sup>126</sup> Usually, the materials used in commercial carpet cleaning are kept a secret. The main reason is colour sensitivity in red fibers. However, industrial cleaning services provide customers with carpets without stains or penetration of red in bright colours.



Talebpour named the chemical solutions used in commercial services as sodium hydrosulfide ( $\text{Na}_2\text{O}_4\text{S}_2$ ) solutions and calcium hypochlorite ( $\text{Ca}(\text{OCl})_2$ ). One spoon of sodium hydrosulfide ( $\text{Na}_2\text{O}_4\text{S}_2$ ) in twenty liters of cool water, and wash with detergents to neutralise the lost colours.<sup>127</sup>

Therefore, after preparing the glossy surface in the laboratory sample and the cross-section of the white material, analysis was performed with a scanning electron microscope (SEM). (Fig. 90) The white material (Fig. 91) inside the carpet was tested. It is the result of the presence of phosphorus and calcium in the composition of materials. Phosphorus is one of the important materials in the production of detergents. During the scanning electron microscopy with energy dispersive X-ray spectroscopy phosphorus and calcium appeared as peaks in the resulting diagram. The small percentage in the material is due to the degradation of the material after absorbing water. (Fig. 92)<sup>128</sup>

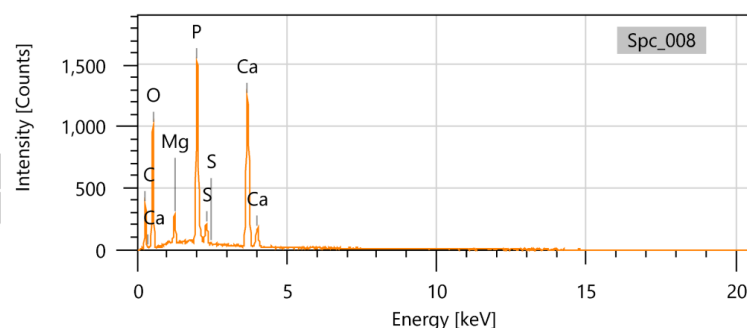


Figure 92 : The result of SEM-EDX.

Phosphonate is one of the materials for chelating calcium.<sup>129</sup> This material was applied between the piles by commercial services after washing the carpet to prevent dye

<sup>127</sup> Talebpour 2008, 2-7.

<sup>128</sup> The analysis of particles attached to fibers using the SEM-EDS microscope was carried out at the Institute for Conservation and Restoration (head: o. Univ.-Prof. Mag. Dr. Gabriela Krist) in cooperation with Sen. Lect. Dr. Farkas Pintér.

<sup>129</sup> Atainejad, Maryam. 2020. What are "Phosphonates"? {definition+types+applications} Chemist. Accessed February 23, 2023. <https://shimichi.ir/phosphonates/>.

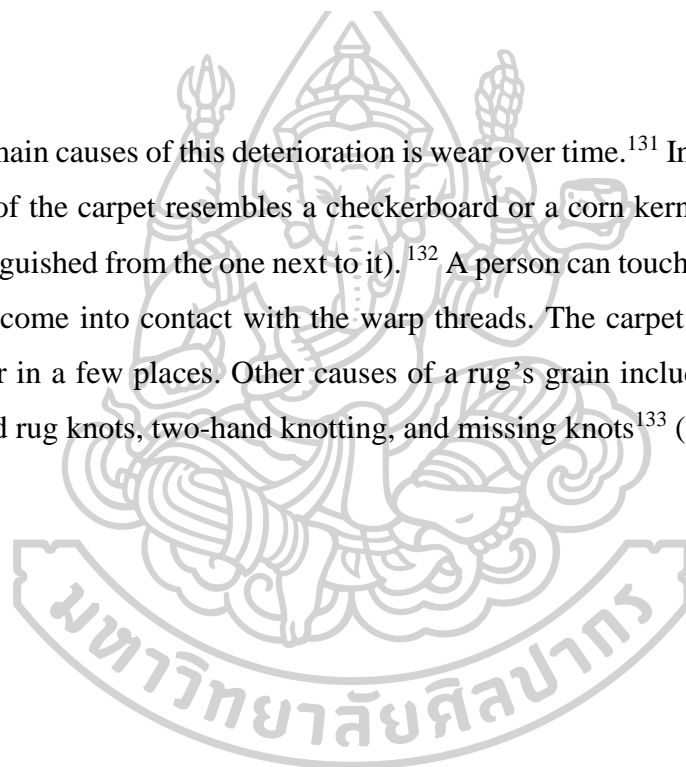
penetration. Phosphonate In detergents that use peroxide bleaching, they act as stabilizers for the bleach.<sup>130</sup>

Table 3 : details the composition's proportion.

| Element | Line | Mass%                | Atom%      |
|---------|------|----------------------|------------|
| C       | K    | 17.93±0.29           | 28.93±0.47 |
| O       | K    | 39.10±0.66           | 47.38±0.79 |
| Mg      | K    | 1.79±0.08            | 1.43±0.06  |
| P       | K    | 14.82±0.22           | 9.28±0.14  |
| S       | K    | 1.93±0.08            | 1.17±0.05  |
| Ca      | K    | 24.44±0.37           | 11.82±0.18 |
| Total   |      | 100.00               | 100.00     |
| SpC_008 |      | Fitting ratio 0.0197 |            |

#### 4.2.8. Corn

One of the main causes of this deterioration is wear over time.<sup>131</sup> In this type of damage, the pattern of the carpet resembles a checkerboard or a corn kernel (each knot can be easily distinguished from the one next to it).<sup>132</sup> A person can touch the ends of the knots where they come into contact with the warp threads. The carpet may have this grain anywhere or in a few places. Other causes of a rug's grain include low-quality wool, disorganised rug knots, two-hand knotting, and missing knots<sup>133</sup> (Fig. 88).



<sup>130</sup> Alcochemminerals.com. 2021. "Phosphonates." Accessed January 1, 2023. <https://www.alcochemminerals.com/product-detail/phosphonates/>.

<sup>131</sup> The corn formation stage may occur as a defect in the weaving of carpets. If the weaver goes beyond this and trims the pile further with scissors, these piles will be thin on the carpet surface. However, these phenomena may be caused by heavy use of a certain area of the carpet or by its age.

<sup>132</sup> Stone, Peter F 1997, 70.

<sup>133</sup> Kargar, Hamid. 2015. "Corn" *TORREH, Persian Handmade Carpet Journal* 10, no. 54 (September): 54 [https://fa.wikirug.org/images/5/5c/Carpet\\_Defects\\_10-Hamid\\_Kargar-WikiRug.jpg](https://fa.wikirug.org/images/5/5c/Carpet_Defects_10-Hamid_Kargar-WikiRug.jpg).

### 4.3. Damage to the selvage

The selvage<sup>134</sup> can be attached to the side of a rug in two different ways: attached (during weaving) or detached (after weaving).<sup>135</sup> Consequently, its damage can be examined in another section on carpet damage. Handmade selvage deteriorates over time, usually ten to fifteen years, and occasionally from heavy washing. However, the three main types of damage a selvage can suffer are: 1. nicks, 2. abrasion 3. loss of selvages.

#### 4.3.1. Selvage abrasion

This damage is caused by the heavy use of the carpet and the possibility that it will wear out. It occurs in the threads above the selvage. It should be noted that we are talking about partial and complete wear only when the selvage is damaged and the warps and knots on the side of the carpet are not damaged. In the case of partial wear, part of the original selvage of the carpet is worn in such a way that the pile and weft threads are not damaged, but there is general wear, which includes two conditions. The first is that the selvage is completely worn but has not reached the warp and weft of the carpet and the second is general wear of the selvage along with damage to the warp and weft of the carpet.<sup>136</sup> In the second damage, parts of the knots and border motifs are also severely damaged.<sup>137</sup>

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<sup>134</sup> The selvage, a base component and one of the supporting pillars of the carpet in Iranian carpets woven in two different styles, may have several damages as one of them is made by a different method and added to the carpet. Of these damages, the detachment of the selvage from the carpet side is the most serious. Therefore, this damage is presented in this section, along with a brief introduction to selvage, which refers to the edges of a rug where the weft threads are wound in opposite directions around the side warps. The selvage sometimes has complicated structures consisting of numerous additional warp threads. On the side of the carpet, selvages usually consist of two to five pairs of weft threads. The warp threads add strength, durability, and beauty to the rug. Although it takes time, this shaping of the selvage during weaving can also cause the rug to stretch inward. As a result, in some of towns such as Azerbaijan (Tabriz) and Khorasan, the selvage is no longer shaped during weaving, and instead, a separate selvage is used that is not part of the main base of the rug.

<sup>135</sup> Zare 2013, 104.

<sup>136</sup> Madlener 2022, 56.

<sup>137</sup> Arbabi 2008, 98-99.

The warped selvage of the object shows considerable wear; in addition, parts of the yarn are missing; nevertheless, the structure and substructure of the selvage, i.e., the lateral wefts of the carpet, are in good condition (Fig. 93).



Figure 93 : 1.The abrasion of selvage, 2.The loss of thread selvage.

#### 4.4. Mapping of the damages

Figures 94–95 illustrate how defects and damage are distributed. Diagrams 83–84 show the defects before weaving, while diagrams 94–95 show the damage afterwards. The results of the study highlight the problematic aspects of the carpet under study. By leveling the damage in each of the carpet components (warp, weft, and knots), the role of each component in the overall damage is determined (Table 4).

Table 4 : Rating to each carpet components.

| Kind of damage                         | Reason   | Warp | Weft | Knot |
|--|--|------|------|------|
| insect damage                          | It may have been attacked by clothes moths         |      |      | +    |
| Abrasion                               | Frequent human movement and low density            |      |      | +    |
| Tearing                                | Looseness of the weft thread                       |      | +    |      |
| Brittleness or pulverization of fibers | Application of regenerative agents during washing. |      |      | +    |
| Roots are lost                         | Frequent walking in an area                        | +    |      |      |
| Incorrect restoration                  | Unfamiliarity with carpet technology               |      |      | +    |
| Loosening                              | Continuous washing                                 | +    | +    | +    |
| Corn                                   | Low density and high Abrasion                      |      |      | +    |
| Total damages                          |  | 2    | 2    | 6    |



- Orange square: Welf thread head
- Red square: Tearing
- Yellow square: Corn
- Blue square: Çişi
- Red square with white pattern: Abrasion

Figure 94 : Dispersion of damages.

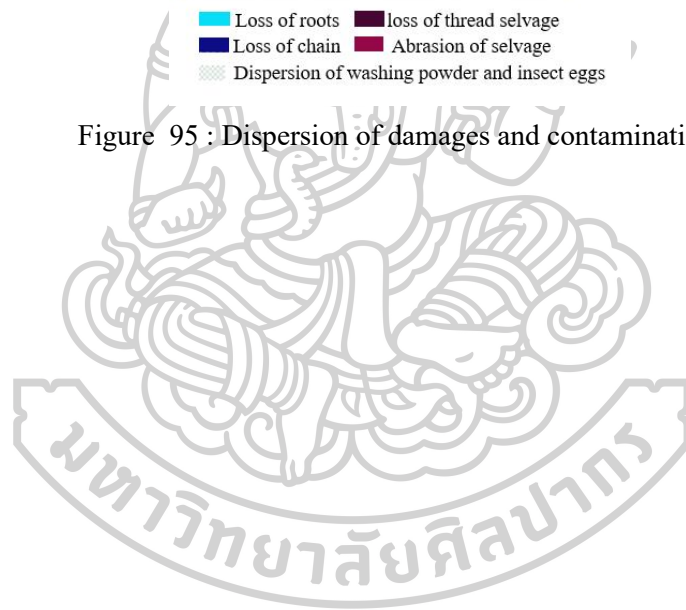






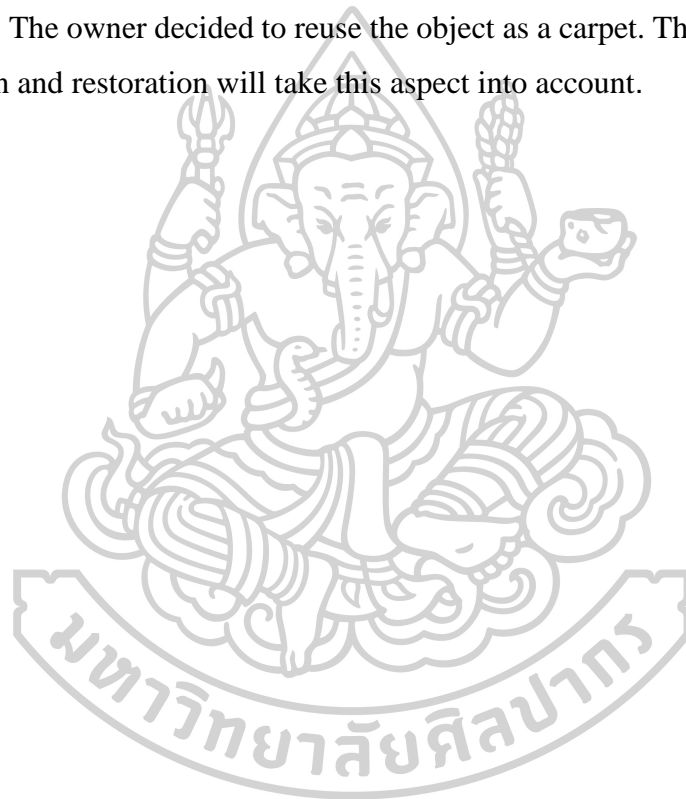
- Loss of roots
- loss of thread selvage
- Loss of chain
- Abrasion of selvage
- Dispersion of washing powder and insect eggs

Figure 95 : Dispersion of damages and contamination.



**5. Aim of conservation and restoration**

The aim of the conservation and restoration is the creation of a concept and the test of conservation trials for the preservation of the object so it can be reused in a more stable condition. The object has some defects that occurred during the knotting process as well as damages that occurred during the usage. The technology and the condition of the carpet is thoroughly analysed to be able to distinguish between these two condition aspects. Defects that occurred during the knotting are considered as part of the manufacturing process and shall not be changed unless the stability of the object is endangered. The owner decided to reuse the object as a carpet. Therefore the concept of conservation and restoration will take this aspect into account.



## 6. Concept of conservation

The process of conservation of the carpet described in this thesis is based on the preservation of the object's authenticity. In the conservation phases, the ideas of reversibility and minimal intervention are taken into account.<sup>138</sup> The materials and technologies used to make this rug were identified and noted based on literature, field research, and laboratory results. Documenting the condition of the object allowed for a better understanding of the current state of the rug. The results obtained guided the conservation process of the object towards an appropriate restoration technique. All decisions are made in consultation with the owner and accordance with due diligence principles.

First, baseline conditions must be established to ensure that it reaches a stable and safe condition. This process should be based on preserving the current condition of the rug, the aesthetic standards of the object, and the principles of the production philosophy. Preservation of all cultural and historical aspects of the object is one of the most important principles.<sup>139</sup>

Surface contaminants such as dust and dirt should be checked and removed at the initial stage to ensure the safety of the conservator and the possibility of proper restoration. After that, a decision should be made as to whether wet cleaning is possible.<sup>140</sup> The roots have suffered severe damage. The roots of the carpet have disappeared up to one centimeter from the row of knots.

The defects sustained during weaving are not included in the restoration process because they are seen as part of the object's technology, history, culture, and philosophy.

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<sup>138</sup> Djordjević, Dragan, Miodrag Smelcerovic, Snežana Urošević, and Suzana Djordjevic. 2017. "Textile Protection through Conservation and Restoration." *Zastita Materijala* 58, no. 1 (August): 94-99. <https://doi.org/10.5937/ZasMat1701094D>.

<sup>139</sup> Kelini, Farhanaz. 2016. "Aesthetics in Restoration." *Restoration and Research* 6, no. 3 (November): 7-16.

<sup>140</sup> Madlener 2022, 99.

Despite being in rather good shape, the object may nevertheless be damaged by corn knots or tension on the warp threads in the root portion. Therefore, by academic conservation should be the priority.

Analysing both conventional restoration methods and the conservation practices used is crucial to determining the extent to which they are practicable. Because a significant amount of the wool threads in the selvage have been lost, the object's selvage is harmed from both a cosmetic and functional aspect. After establishing the extent to which intervention in this sector is conceivable, the best solutions should be chosen.

In the past, rugs were repaired using simple techniques. One of the most common repairs that owners (weavers) of the time made to their rugs was to patch the holes and sew up the edges of the tears to prevent the damage from spreading. Examples of this repair technique can still be found today in nomadic societies, which have only a tenuous connection to urban societies.

In the Iranian carpet market, three categories of carpet exist. 1. New carpets less than 25 to 30 years old. 2. Old carpets that range in age from 30 to 100 years. 3. Older than 100-year-old historic carpets<sup>141</sup>. Depending on the age and condition of the carpet, these three groups of carpets require different restoration methods in Iran.

Group 1 carpets are usually restored so that no restoration marks are visible on the carpet. Restorers treat damaged parts with materials and technologies similar to those used in the manufacture of carpets. The second group includes carpets that have the strengths required for restoration and are restored according to the wishes of collectors, like the carpets in the first group. And carpets that do not have the strength required for restoration and on which only protective measures are carried out. The third group are carpets over 100 years old that are protected or restored according to museum standards. On this basis, the ideas and methods accepted by the masters of this art in the field of restoration underwent many changes and transformations over time, which directly affected the working methods and restoration techniques. Today, the latest theory of interest in museums and major restoration centers is that the restorer does not have the

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<sup>141</sup> Rahimpur, Shahdokht. 2019. "Electronic Content in the Virtual Training of Workshop Courses in the Field of Carpets (with an Emphasis on Two Courses on Carpet Weaving and Repair)." *National Conference on Virtualization of Workshops and Practical Courses in the Field of Art: Challenges and Solutions*. <https://civilica.com/doc/1217273>.

right to add anything to the original work, but should only try to preserve and maintain the remaining parts of the object and take measures to prevent further damage. In other words, conservation and restoration are carried out to preserve the integrity of the material and ensure respect for the cultural, historical, aesthetic, and artistic significance of the object.<sup>142</sup>

To consider how to satisfy the private owner while maintaining the highest standard of protection, this research uses all the possibilities and potentials available in the methods of protection and restoration.

### **6.1. Cleaning**

This process is divided into two methods: dry and wet cleaning. Brushes and vacuum cleaners are used for dry cleaning. The steps of wet cleaning depend on the colour stability of the threads. Specialised tests will be used for this.

#### **6.1.1. Dry surface cleaning**

Since dry cleaning is considered a form of physical cleaning, this method must be done with special care, as a little pressure can cause the knots to loosen. Therefore, proper equipment should be used when dusting. Therefore, a museum vacuum cleaner with adjustable suction power was used, as were additional tools to be inserted into the vacuum cleaner nozzle (Medium suction power). A protective net was used to prevent knots from being sucked in.<sup>143</sup>

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<sup>142</sup> Khan Mohammadi, Hanana. 2017. "Terminology of Words Used in Conservatorship Decisions." *Journal of Protection and Restoration*, no. 1-2 (February): 1-6.

<https://farhangi.tabriziau.ac.ir/Uploads/User/687/files/%D9%86%D8%B4%D8%B1%DB%8C%D9%87%20%D9%85%D8%B1%D9%85%D8%AA%20%D9%88%20%D8%AD%D9%81%D8%A7%D8%B8%D8%AA.pdf>.

<sup>143</sup> When vacuuming the back of the carpet, it is crucial to use considerable caution. The vacuum cleaner's suction power must be adjusted. The back of the carpet is less vulnerable than corned or loose knots. Because the parts of the stems of the knots are worn, they don't have a solid connection to the warps. Dust clearance should be done delicately by identifying the direction of the knots since soil frequently seeps between the piles. Sensitive carpets may suffer if the vacuum cleaner's nozzle head is pulled against the recommended path.



A net should be placed on a vacuum to avoid swallowing the knots. While the vacuum cleaner is at a distance of a few millimeters on the carpet, the brush works directly on the carpet and in the direction of the knot. A brush was used to clean the dust in the area behind the carpet and roots<sup>144</sup> (Fig. 96).



Figure 96 : Dry cleaning and restoration tools.

After dusting, the surface of the carpet was visited. In the parts where there was no surface damage, the operation was repeated. Insect eggs and white contamination have created a strong connection to the lint. Insect eggs are located under the piles and cannot be removed with a medium-suction vacuum cleaner, so each row of the carpet was checked individually, and the insect eggs were separated from the piles using tweezers. Solid white powders were also separated from the fibers in the same way (Fig. 97).

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<sup>144</sup> Ahmadi, Zahra. 2015. *Scissoring in Hand-woven Carpet*. Tehran: Yesavoli.



Figure 97 : Dry cleaning and removal of insect eggs and white contamination.

### 6.1.2. Wet cleaning

Wet cleaning<sup>145</sup> can thoroughly remove dirt, but it should only be utilised to do so. Dust acts as a barrier and should be removed using dry cleaning. Because there are many different colours of carpet,<sup>146</sup> some of which are susceptible to moisture or washing,

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<sup>145</sup> This is accomplished by placing fiber samples from each hue between two sheets of absorbent paper (blotting paper). Water that has been deionized is used to wet the top layer. An overlay of glass is then placed on top of the paper. If no colour bleeding takes place and every yarn in the test retains its structural colour, the test is repeated with a different solution and a greater elaborate percentage. The conservator is permitted to utilise wet cleaning after going through the safety requirements.

<sup>146</sup> Landi, Sheila. 1997. *Textile Conservator's Manual*. London: Routledge.  
<https://doi.org/10.4324/9780080518749>

all coloured threads should be checked<sup>147</sup> to see whether the carpet is safe for wet cleaning.<sup>148</sup>

During the test, samples were taken from different areas of the carpet.<sup>149</sup> These samples were extremely loose knots. These samples were from parts of the carpet that had little effect on its motifs. The red fibers added a little colour to the paper in the first step when deionized water was used. In Figure 150, the fibers in the second round of testing were soaked with the solution used (Marlipal® 2%)<sup>150</sup> (Fig.98). This test shows that the stronger the cleaning solution, the more dye is removed from the fibers (Fig.99). In both experiments, red lost more colour. Therefore; the next step and the use of a stronger solution were not done.<sup>151</sup>

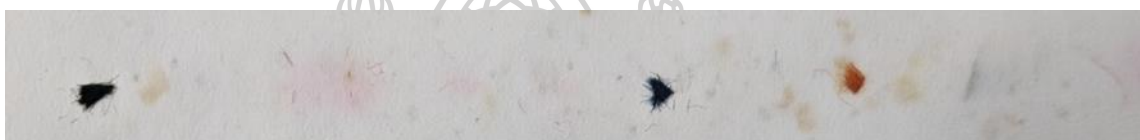


Figure 98 : Wet cleaning test with Marlipal® 2%.



Figure 99 : Test on 11 samples isolated from knots and blue weft thread.

<sup>147</sup> Samy, Mariam G., Gamal Mahgoub, Eman Osman, and Neven Kamal. 2022. "Restoration and Conservation of a Unique Archaeological Carpet from Prince Muhammad Cali Palace Museum in Al-Manial, Cairo (Case Study)." *Journal of the General Union of Arab Archaeologists*, (January): 198-218. [https://jguaa2.journals.ekb.eg/article\\_194840.html](https://jguaa2.journals.ekb.eg/article_194840.html).

<sup>148</sup> The sampling and colour fastness of fibers analysis was carried out at the Institute for Conservation and Restoration (head: o. Univ.-Prof. Mag. Dr. Gabriela Krist) in cooperation with Univ.-Ass. Tanja Kimmel. See pages 31–32.

<sup>149</sup> Appendix III, is the sampling location based on the protocols

<sup>150</sup> Madlener 2022, p. 99.

<sup>151</sup> The sampling and colour fastness of fibers analysis was carried out at the Institute for Conservation and Restoration (head: o. Univ.-Prof. Mag. Dr. Gabriela Krist) in cooperation with Univ.-Ass. Dipl. -Rest. Tanja Kimmel.

## 6.2. Securing the damaged parts

According to the investigation done on the damages to the object and also the opinion of the owner of the carpet, the repair of three damages was placed as a priority. Strengthening, restoration, and homogenisation of selvage, torn surface threads, and carpet roots are included. Less material should be utilised for repair wherever possible. Different materials respond differently to environmental factors. The expansion and contraction of the new materials employed in the restoration of textiles, such as carpets, are different from those of the historical object as a result of a temperature change. Additionally, the water absorption of old and new fibers differs, which might lead to variations under the same circumstances. Therefore, minimal materials should be used in restoration.<sup>152</sup>

### 6.2.1. Roots

The roots, which are located on the edge of the carpet, are always more vulnerable to harm. One of the causes of this is that the roots are lying free from one another and are not intertwined. Consequently, securing and protecting the roots is one of the most crucial precautions to take to protect the carpet.

Consideration should be given to the nature of the damage and strategies for conservation and restoration before beginning this work. The combination of different protection or restoration techniques can be considered to serve this purpose. The roots

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<sup>152</sup> Schwenck, B. 2004. "Cleaned - repaired - and refreshed with new colours. preservative and Tapestry restoration methods. Unpublished undergraduate thesis." Diplom., Institute of Conservation, University of Applied Arts Vienna.

of the carpet are typically secured tying them up,<sup>153</sup> this is one of the steps in the carpet finishing process<sup>154</sup> (Fig. 100-101).<sup>155</sup>



Figure 100 : Chain knot.



Figure 101 : Two knots.

About one centimeter of the roots of the carpet is still present. The rows of knots are rootless in some places where the roots have been completely lost.<sup>156</sup> Some academic techniques deemed appropriate for this carpet include putting supporter roots below,

<sup>153</sup> The process of tying off is typically not carried out at the roots of nomadic carpets. Traditionally by chain-weaving and tying off, the roots are protected from harm. The object is one of the carpets whose roots have remained unbound after the knotting process. The use of Two-knots on carpets with damaged roots is the traditional restoration technique. However, the roots must be in good condition for this method to work.

<sup>154</sup> Arbabi 2008, 56-63.

<sup>155</sup> Khadamatfarsh.ir. 2021. "Introducing the Types of Knots at the Root of the Carpet." Accessed March 30, 2023. <https://mirzaie.loxblog.com/post/30>. <https://khadamatfarsh.ir/%DA%AF%D8%B1%D9%87-%D8%B1%DB%8C%D8%B4%D9%87-%D9%81%D8%B1%D8%B4/>.

<sup>156</sup> In the traditional restoration method, new roots have to be introduced into the carpet to add Two-knots or to loosen the row for new tying, using warp threads as roots. Insertion of the needle in rooting traditionally, tension and pressure in rooting, and pulling out old roots are the major damage caused to historical carpets in traditional restoration. Since this procedure is regarded as invasive on carpets, academic techniques must be used for it.



sewing a lace cover on the roots, and reinforcing the rows of the carpet's beginnings with a small needle. Technical sewing (Herringbone stitch) is a suitable implementation strategy to strengthen the first rows, where abrasion has shortened the roots. In this procedure, which is depicted in Figure 102, the yarn reinforces the rows in which the chain is abraded or loose and the roots are loose. The needle moves back and forth between the rows, securing four or five rows together. For parts where there is no root, installing a supporter can be a conservative strategy (Fig. 103). The rows that have slipped towards the roots due to chain or weft threads are strengthened. Support covers the range of tears.

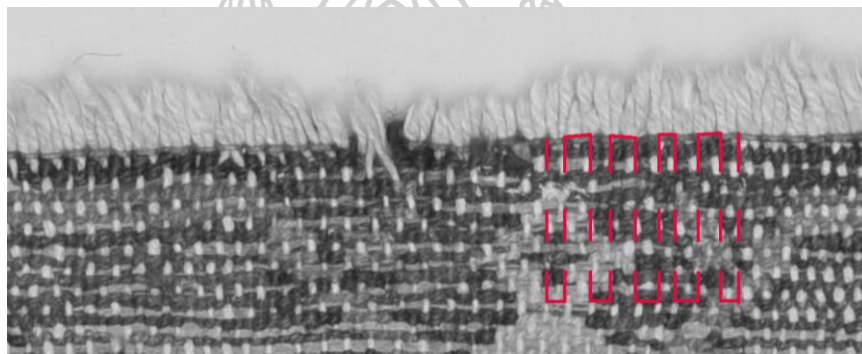


Figure 102 : Strengthening the rows that have slipped towards the roots using the running stitches method.

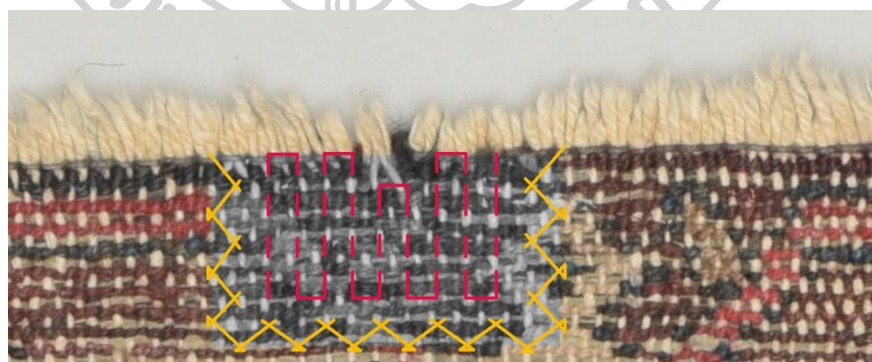


Figure 103 : Installation of support in the torn section (Herringbone stitch).

However, if the carpet is folded during storage, the increase in surface area on the back of the carpet may present a new challenge and damage the object. Therefore, whenever

possible, fastening by technical sewing is preferable to gluing. Also, it is best to avoid brand new materials that vary in age or react differently to environmental conditions.

### 6.2.2. Selvage

The use of two selvage methods in historical carpets shows that the restoration techniques for these two types should be different. The objects selvage is of the continuous type. In the traditional restoration of worn threads in the selvage region, they are repaired with homogeneous threads. This method is used when the structure of the selvage region is in excellent condition.

In the traditional method, if the damage has spread to the entire edge of the selvage and its repair is not economical, the whole part of the selvage is cut and a new selvage is applied on the carpet. This method is considered invasive and causes irreparable damage to the carpet. According to conservation science, this approach, which causes damage to the object, cannot be used. Scissors, (Fig. 104) cutting the old selvage, (Fig. 105) shortening the knots on the side of the Selvage (Fig. 106), needlework, (Fig. 107) passing thick thread, (Fig. 108)<sup>157</sup> and finally pulling the two sides of the selvage (Fig.109 ) are some of the things that can be harmful to the historical object.



Figure 104 : Scissoring the old selvage.



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<sup>157</sup> Arbabi 2008, 25-30.

Figure 105 : Shortening the stem of knots.



Figure 106 : Applying pressure to smooth the edges.



Figure 107 : Needlework.



Figure 108 : Passing thick thread.



Figure 109 : Pulling the two sides of the selvage.

Academic and traditional methods are researched to get the optimum method of restoration about the homogeneity of the damaged areas of the selvage with the healthy parts.<sup>158</sup>

The selvage section of this carpet is curved and waved.<sup>159</sup> Hence, the use of a support fabric throughout the rug may result in different stretches or gaps between the carpet and non-elastic fabric sections. Therefore, it is important to look for conservation strategies or alternative techniques that can be influenced by both traditional and academic techniques, including the use of homogenous yarns to wrap the affected area. (the edges where there is no selvage thread) (the traditional method) and the use of a fine net on areas where abrasion causes tearing of selvage threads (the academic method) (Fig. 110-111). The net can be considered an efficient way to protect the selvage part due to its elasticity, which allows it to follow the flexibility of the selvage according to the bends. The mesh also allows the restorer to homogenise colours. This method is flexible when rolling the carpet and is also effective for storing carpets. Placing the support under the destroyed selvage and performing technical stitching are other methods for preserving the integrity of museum carpets.

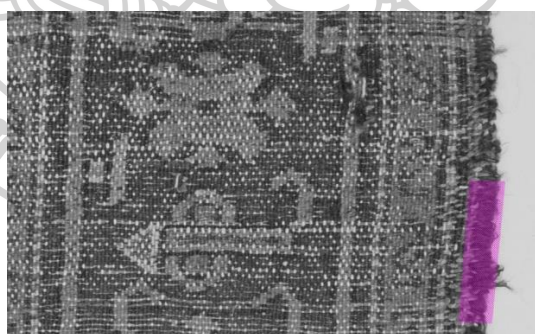


Figure 110 : Use of a fine net on areas where abraded.

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<sup>158</sup> In the majority of conservation projects, the selvage of the carpet or damaged sections is coated following restoration. A support may be used to hold the selvage in place, depending on how well it is functioning.

<sup>159</sup> Landi 1997, 30.

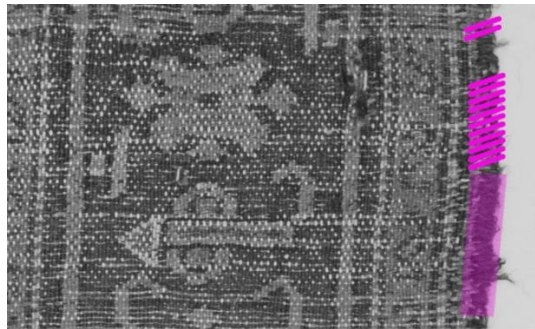


Figure 111 : Use of homogenous yarns in the affected area.

### 6.2.3. Tears

The tearing of this object includes tearing in the weft threads. The part of the edge of the carpet that is about 5 cm long and 1 cm wide is the part where the wefts are the most torn. There are six released warp threads but no weft threads. The warps are visible in the carpet's background. Protection in this section includes support for the remaining six warps and around the tear.

Renovations have previously been carried out on the object. To conceal the free warps existence, some knots were placed on two of the warps so that the torn area could not be seen. Due to the lack of stability in the tear area and the loose threads, the past restoration played a destructive role. That means that the restorer has already cut the torn wefts. To restore this part, the restorer used coloured threads and started them by passing the thread in a U shape. This method causes damage to the object without implementing support. To perform this step, the restored parts must be removed first. Therefore, conservation includes the elimination of previous restoration that plays a damaging role. Protecting this part prevents the warps from moving and tearing apart. There should also be a supporting role left for the six warps. Homogenising the freed warps with the hues of the motifs will improve the carpet's aesthetics.



The commercial repair method<sup>160</sup> involves completely repairing the damaged portion of the carpet for structural integrity (Fig. 112-114).<sup>161</sup> In the traditional method, after creating the carpet network, the repairman creates the knots of the carpet with a needle or hook in various ways. This approach cannot be used since it is invasive and attacks the healthy areas of the carpet. In this method, unfavorable pressure is applied to the other areas of the carpet.



Figure 112 : Passing the weft between the threads.



Figure 113 : Knotting similar knots.

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<sup>160</sup> In the traditional method, the damaged part of the carpet structure is completely repaired using the commercial repair technique. That is, the weft threads in this part of the carpet are completely restored to their original shape. This operation includes weaving the new weft between the warp threads. Parts of the new wefts should be placed next to the wefts of the historical carpet. Thick needles and materials similar to the object are used for this process. The reason for using high-grade needles is their ability to guide the thick cotton threads of the weft into the historical carpet. This process usually includes a radius of 10 cm of the carpet, and the needle is taken into the carpet to strengthen the new wefts.

<sup>161</sup> Arbabi 2008, 67-70.



Figure 114 : Integration with thin weft.

New materials may also respond differently to environmental effects due to their varying elasticity from existing components. Due to shifting environmental factors, newly stretched knots and threads undergo various contractions and expansion. Older materials may absorb less water or moisture because their fibers are less responsive to such influences.<sup>162</sup> The structure of the restored portions on the carpet's body also makes it impossible for the repaired parts to be reversed, and removing the new repairs could result in the collapse of the entire area surrounding the tear.

According to the conservation principles, the torn sections of the damaged carpets are supported with support (Fig. 115). The support function is to take care of damaged parts. Cutting a strip of cloth with the same colour as the background<sup>163</sup> and patching it below the damaged part is considered a protection method.<sup>164</sup> Usually, the loose parts are connected to the support to prevent their movement. The sewing (*laid cauching*) direction is along the weft threads, and their distance is equivalent to one row. Several rows of stitches are continued above and below the damaged area for further reinforcement (Fig. 116-117).

To prevent damage when the carpet is rolled, it is best to cover the restoration area for initial support. When sewing securely, conditions must be created for placing the

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<sup>162</sup> Madlener 2022, 106.

<sup>163</sup> Neugebauer, H./Schmitz von Ledebur, K. 2008. "Cleaning and Conservation of the Brussels Tapestries im Napoleon Room at Schönbrunn Palace." *Restauratorenblätter*, March 8, 2008. 111-115.

<sup>164</sup> Catic, E. 2021. "And how does my stitch behave now?" An attempt at an evaluation of sewing technology Safety measures on tapestries, in: Association of Restorers (VDR) e. V. (ed.), *Reopened! A fresh look at methods and materials in textile restoration*. Online conference of the textile specialist group.

support fabric. After the technical sewing is finished, the extra supporting material is cut.

All suturing methods should be studied to plan an efficient method of protection. According to of the carpet on the similarity of the restored parts with the appearance of the carpet, the colour, and selected fabric should be the same as the restored parts. The materials used should prevent possible damage to the carpet (Fig. 118).

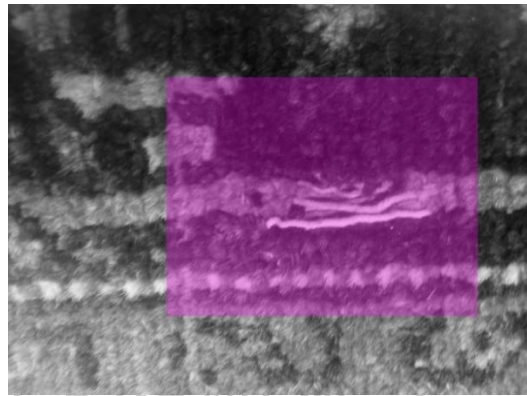


Figure 115 : Placing a support on the damaged section.

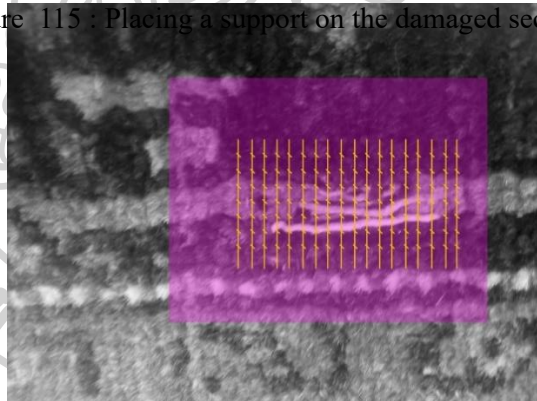


Figure 116 : Stitching (laid cauching) along the weft rows.

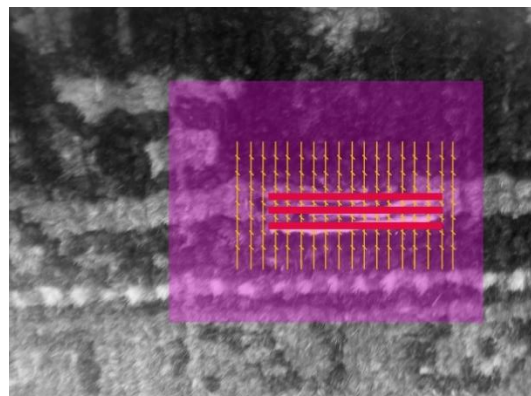


Figure 117 : Placing the warps in their original position.

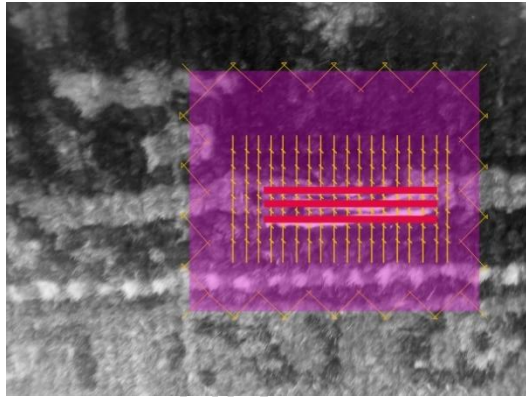
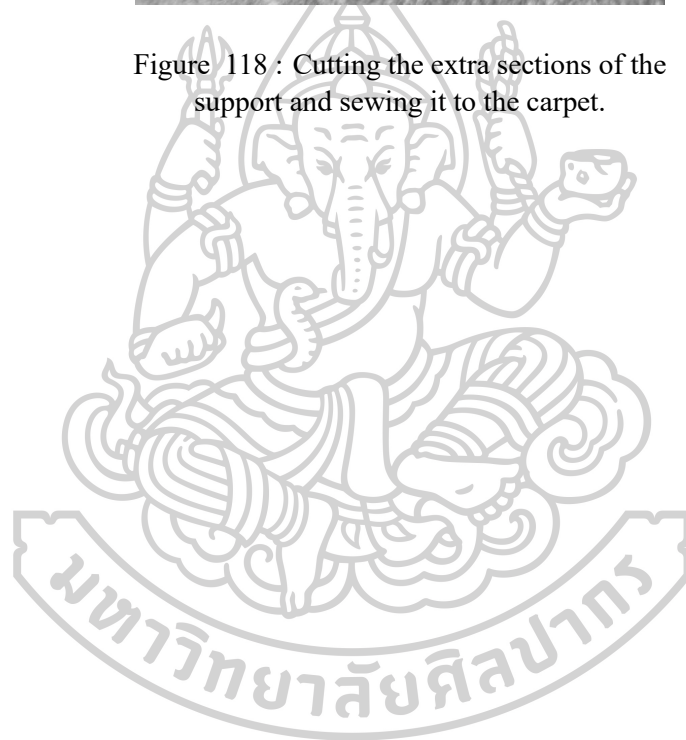


Figure 118 : Cutting the extra sections of the support and sewing it to the carpet.



## 7. Measures carried out

Priorities include dry cleaning before the restoration, including removing dust on the object. The safety conditions of the workshop, as well as the equipment for the restorer and the object, are checked before beginning the practical work.

At this stage, the work table was first prepared and adjusted according to the desired height. There are holes on the surface of this table that allow access to the bottom and middle of the carpet without moving it. After covering parts of the table with paper, the object was placed on it.

### 7.1.1. Securing of the torn selvage

There are two major damages to the selvage that need restoration. The restorations include two abraded parts and areas without piles. The abrasion has caused some of the wool threads to be torn and visible in the corners of the carpet. Support for the torn threads is on the agenda. Two methods were used: 1. Supporting threads with new threads 2. Using the net to cover the torn threads

In the first place, new threads were added in the parts where the height of the selvage is low and abrasion has caused the loss of part of the woolen threads. The ends of the torn threads were placed behind the new threads.

The selvage restoration method is followed traditionally and is based on carpet technology. This method does not damage the carpet, but on the holes in the Selvage corner, a wool thread is applied to the edges with the help of a needle. The method of this repair is similar to the traditional screw selvage method, which is explained in the section on repairing missing parts. Then, to restart, needles and woolen threads are inserted between the new selvages to prevent damage to the carpet. Through the openings left by the original selvage, the needle moves. The entire process of selvage restoration is non-destructive (Fig. 119-120).

Netting in the same colour as the selvage holds the ripped wool strands in place. Thread ends can be further secured from tearing by placing them under the net. A net was installed to protect the wool fibers as well as the object's aesthetic aspects. A lace with a fine mesh and the same colour as the wool thread was chosen, which is crimson. (Fig.121).The lace placement method was done with the help of thin woolen thread and



a needle. Since the original parts of the selvage are curved, the place where the needle sinks in between the holes of the weft rows prevents damage to the object (Fig.122). In this section, a curved, thin needle was used. The thread used is made of wool, crimson brown, and Semi-glossy. The method used in this section is fully protective, museum-quality, and reversible.<sup>165</sup>



Figure 119 : Using a technologically homogeneous technique.

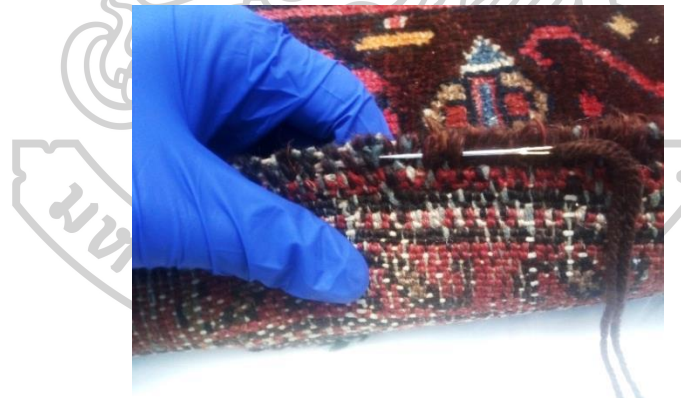


Figure 120 : Pass the needle through the new thread.

<sup>165</sup> Anchor® Wool/Cotton Machine Embroidery, No. 100/2, Col. 801.



Figure 121 : Installing a net on selvage.

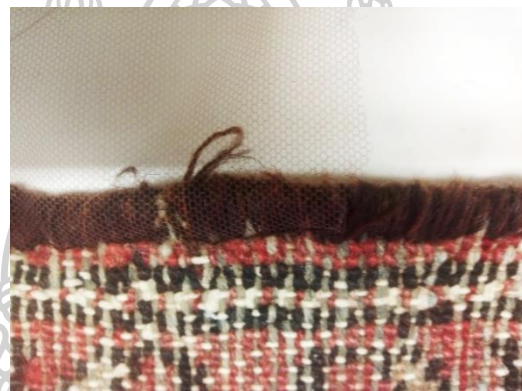


Figure 122 : Protection of selvage threads with use of the net.

In some areas of selvage, all the woolen threads have separated due to damage brought on by abrasion to the underlying layers. The restoration method for this part was considered based on the direct opinion of the carpet owner. For this purpose, woolen yarn of the same colour and homogeneity as the original woolen yarn was used. Threads were wrapped in empty areas based on carpet technology. The entry and exit points of the needle are in the interweave cavity (Fig.123). These holes have lost the passage of selvage woolen thread, so this object is not damaged. This whole process is reversible and does not cause damage to the object. Using this technologically homogeneous technique, the woven surface was reconstructed in a manner comparable to the woven method. The direction of wrapping the selvage is from the back of the carpet and from the bottom of the carpet to the top of the carpet so that the new texture is aligned with the remaining parts. A smooth needle with medium thickness was used to restore this

part. The yarn used is crimson, semi-glossy wool. This method is a complete conservation method with an academic approach and is reversible.



Figure 123 : The restored section of selvage.

### 7.1.2. Securing of the roots

One of the most damaged components of the object is its root section. Due to significant abrasion, the roots have become shorter. By supporting the roots, one can help the object's overall strength while also preventing future harm to the carpet. As a result, during routine transfers or visits, the carpet won't sustain extra harm. Two restoration techniques and one protection technique were selected, and they are as follows: 1. restoring the roots in the chained portion 2. root restoration in the chain-free portion 3. installing a net on the roots.

The primary, less damaged components are strengthened before the supporter is applied to the affected areas.

Repairing the roots of the chain part: in the parts where the end is connected to the chain, they get strength, so this part is only strengthened. In this method, about 4 centimeters of the top and bottom of the carpet and along the roots are sewn (Fig. 124). The method of sewing and making stitches happens between the weft rows (Fig. 125).<sup>166</sup> For this method, the supporting fabric is not used because the roots cannot bear the maintenance of the supporter and there is no solid part for the support. A thin, curved needle was used to restore this part. The type of thread used is woolen in a matte brown colour.

<sup>166</sup> Madlener 2022, 115.

The initial rows of the carpet are reinforced using technical sewing with the Festonstichen stitch. This stitch enables the needle to move from the object's edge to its surface. Between 4 and 5 cm, the needle reinforces the rows by moving through the wefts.<sup>167</sup>



Figure 124 : Strengthening the roots.

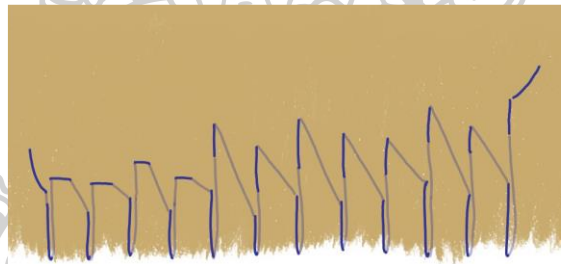


Figure 125: Strengthening method in the chain

Repairing of the chainless part: In this part, a small fabric support is used instead of the missing chain. This support is under the parts that are filled or run due to the laxity of the sliding rows (Fig. 126). The sewing method is similar to the previous part (Fig. 127). To keep the fabric's threads from unraveling, a technical sewing called a Hexenstich is utilised to attach the fabric to the carpet's backing (Fig. 128). A thin, curved needle was used to restore this part. The type of thread used is woolen in a matte brown colour. According to conventional repair methods, the colour of the backing

<sup>167</sup> Bergt, Eva. 2013. "Removal of Tapes on "Coptic" Textiles from the Papyrus Collection Austrian National Library, Vienna." Diplom., Institute of Conservation, University of Applied Arts Vienna.

fabric is matched to the texture and tonality of the object to be fixed. This means that the two components of shadow and shadow depth must be properly matched.<sup>168</sup>

The pieces should be positioned below the flaw after being cut with zigzag scissors, and sewing-technical fastening should be done on it. Once the sewing-technical fastening is complete, the sliced pieces can be recut. The borders are next joined to the back and fastened with Hexenstich if there was no lining.<sup>169</sup>



Figure 126 : Strengthening method in the torn chain area.



Figure 127 : Installation of support behind the roots.

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<sup>168</sup> Madlener 2022, 130.

<sup>169</sup> Madlener 2022, 109.



The fabric is installed by inserting the needle into the surface. The carpet may become damaged if the needle is inserted too deeply. Installing the supporter (Hexenstieg)<sup>170</sup> requires a thin, curved needle and matching natural thread<sup>171</sup> in the same colour<sup>172</sup> (Fig. 128).



Figure 128 : Using technical sewing (Herringbone stitch) to attach the support.

### 7.1.3. Securing of the torn parts

The next steps include the fabric and then technical sewing to strengthen the warp threads, but since the owner of the object insists on the homogeneity of the warp threads with the coloured parts of the carpet background, before installing the fabric, the warps are homogenised with the help of woolen threads.

Homogenisation of warps: A very basic method is used to homogenise the threads. The execution method is that the woolen thread is wrapped around the warp thread. Considering that the warp yarn is on the surface and the other three yarns are on the back of the carpet, only the top three yarns are wrapped with woolen yarn. This makes

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<sup>170</sup> Bergt 2013, 132.

<sup>171</sup> Benson, Sarah J., Frances Lennard, and Margaret J. Smith. 2014. "Like-With-Like': A Comparison of Natural and Synthetic Stitching Threads used in Textile Conservation." Conference: International Council of Museums Committee for Conservation, 17th Triennial Conference At: Melbourne. [https://www.researchgate.net/publication/274222507\\_'Like\\_with\\_like'\\_A\\_comparison\\_of\\_natural\\_and\\_synthetic\\_stitching\\_threads\\_used\\_in\\_textile\\_conservation](https://www.researchgate.net/publication/274222507_'Like_with_like'_A_comparison_of_natural_and_synthetic_stitching_threads_used_in_textile_conservation)

<sup>172</sup> DMC ® Machine Embroidery Thread, 100% mercerized cotton, size 50, col. 1533.

the surface of the restored part look homogeneous with other parts, and the viewer sees the surface of the carpet without visual defects at first glance (Fig.129-130).



Figure 129 : Warps left in the torn part of the wefts.



Figure 130 : Homogenisation of warps with woolen pile.

The cotton fabric was trimmed to reattach the released threads to their original position. The cloth was positioned in the warp area and behind the carpet. With the help of a needle, the threads were spun into fabric. Secure stitching laid couching<sup>173</sup> was used to connect the warp threads to the support. The sewing distance in straight lines (spacing)

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<sup>173</sup> In German-language literature, the term "Spannstich" is used.

was chosen to be about 4-mm<sup>174</sup> (Fig. 131). This distance was chosen due to the greater strength of the threads; on the other hand, the passage of the thin thread between the threads depends on the place where the weft thread passes in the carpet. After the technical sewing (laid cauching) was completed,<sup>175</sup> the excess fabric was cut off. It was tied to the back of the carpet with the herringbone stitch sewing method. A thin, curved needle was used to restore this part. The yarn used is woolen in a matte brown colour<sup>176</sup> (Fig.132-133).



Figure 131 : Connecting the warp threads by secure stitching (laid cauching).

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<sup>174</sup> Costantini, Rosa. 2021. "Strain across Historic Tapestries: A Multi-analytical Investigation on Damage Mechanisms and Conservation Strategies." PhD thesis, University of Glasgow.

<sup>175</sup> Bergt 2013, 132.

<sup>176</sup> Trosbach 2002, 83.



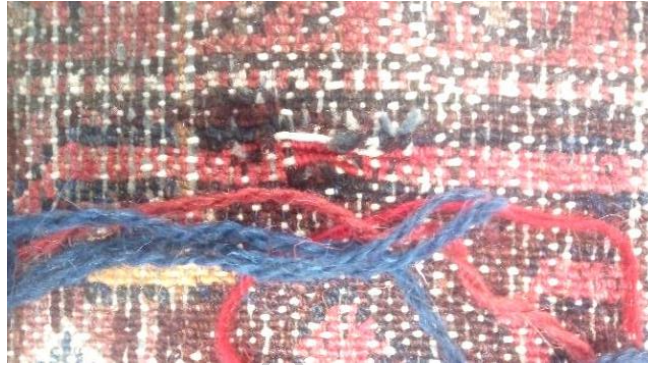
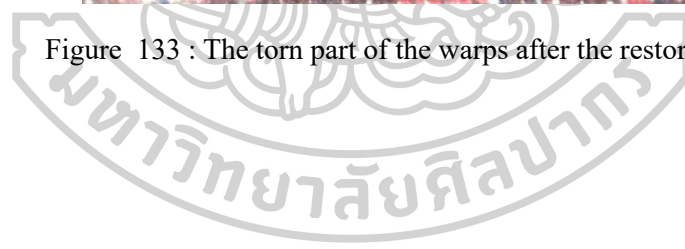


Figure 132 : The torn part of the warps before installing the supporter.



Figure 133 : The torn part of the warps after the restoration.



## SUMMARY

A private collector living in Vienna gave the Hamadan hand-woven carpet (~1900) to the Institute of Conservation's workshops at the University of Applied Arts Vienna to be re-conserved. Comparative studies were used in the first chapter to discover the origin of the carpet. This required substantial library research. Finally, the object was identified as being from the Hamadan region of Iran by comparing the patterns, motifs, and colour scheme. The approximate age of the object is 80 to 100 years based on the patterns and motifs and the condition. Hamadan nomads have woven the piece. It is rural in style and similar to the patterns weaved in Hamadan's Asad Abad village.

The materials and tools used in carpet weaving in Iran, particularly in the Hamadan region, were discussed in the second chapter. The sorts of looms, hooks, and scissors utilised, as well as the threads used in the region's carpets, are investigated. The dyes used in wool dyeing were examined further.

A technological survey is covered in the third chapter. A tiny component of the object was reconstructed using the knowledge from the second chapter as well as the technical study of the object. The warp and weft threads were identified as cotton by studying the fibers using polarised light microscopes and comparing them to the fibers of the Conservation Collection and the knots are identified as wool. As a mockup, a section of the object was rebuilt to match the technology of the patterns by creating these materials and depending on the density of the object (20 knots per 7 cm). The object's defects during weaving knotting were studied. Eight defects that occurred during the object's weaving have been discovered. These defects, which represent the weaver's culture, ideology, and lack of talent, cannot be corrected and are regarded as part of the object's history.

The fourth chapter looked at the object's condition. There were eight damages on the object. 1. pest infestation; 2. abrasion; 3. tears; 4. brittleness or pulverization of fibers 5. loss of roots 6. incorrect restoration 7. loosening of the carpet 8. corn. The selvage also comprised two types of damage: abrasion and pile loss. This chapter attempted to evaluate the damaged variables in each part and present their allocation in the carpet's material levels and surface.

The aim of conservation and restoration was defined in the fifth chapter. Because the object has a private owner, the owner's opinions are directly considered in the



continuation of the process. According to the carpet's owner, the object will be reused. As a result, the owner believes that the restored sections in selvage should be similar to the object's original sections. To prevent further destruction, the tears and roots have been strengthened and protected.

The sixth chapter delved into the concept of conservation. The thesis attempted to select the best ways in this chapter while reviewing prevalent methods of traditional and academic restoration.

In the seventh chapter, restoring process of the selvage of the object with the combination of a traditional and an academic approach explained. In this method, wool similar to the original selvage was used to recover the missing selvage wool. A net was used to protect the abrasions and loose portions of the selvage. To keep the torn chain of the root sections together, textile support was used. Six warps released on the surface of the carpet were strengthened and repaired during the restoration process.

In conclusion, the object's state was preserved, and the damaged sections were protected for later use. When reusing the object, the damaged pieces were secured using technical stitches and support to prevent further damage. Selvage significantly increased the necessary strength. The carpet might be reused more effectively if any loose components, such as torn fibers and roots, were present.



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