



ANALYSIS OF BORDER PATTERNS WITH PMM2 SYMMETRY IN MACEDONIAN FOLK COSTUMES

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ABSTRACT: Border patterns represent one of the most prominent decorative elements in Macedonian folk costumes, combining aesthetic, structural and cultural functions. Among the different classes of patterns developed along a single axis, those exhibiting bilateral symmetry, are of special interest due to their frequent occurrence and balanced visual composition. This study focuses on the analysis of border patterns with bilateral symmetry in Macedonian traditional textiles, with an emphasis on the pmm2 symmetry class. Photographic documentation of traditional costumes from various ethnographic regions was collected and transformed into simplified linear representations for symmetry classification. The patterns were analyzed according to established symmetry principles, identifying the presence of translational repetition combined with vertical and horizontal mirror reflections characteristic of the pmm2 group. Among the analyzed examples, border patterns exhibiting pmm2 symmetry appeared frequently, especially in decorative elements positioned along sleeves, necklines and hems of traditional garments. Their symmetrical structure contributes not only to visual harmony but also to functional stability of the textile elements. The study highlights the importance of bilateral symmetry in preserving cultural identity and offers a basis for contemporary textile design inspired by traditional Macedonian ornaments.

Keywords: border patterns, pmm2 symmetry, bilateral symmetry, Macedonian folk costumes, textile ornaments.

ANALIZA BORDURNIH ORNAMENATA SA PMM2 SIMETRIJOM U MAKEDONSKIM NARODNIM NOŠNJAMA

APSTRAKT: Bordurni ornamenti predstavljaju jedan od najistaknutijih dekorativnih elemenata u makedonskim narodnim nošnjama, kombinujući estetsku, strukturnu i kulturnu funkciju. Među različitim klasama ornamenata razvijenih duž jedne ose, posebnu pažnju privlače oni koji pokazuju bilateralnu simetriju, zbog svoje česte zastupljenosti i



uravnotežene vizuelne kompozicije. Ova studija fokusira se na analizu bordurni ornamenata sa bilateralnom simetrijom u makedonskom tradicionalnom tekstu, sa posebnim osvrtom na pmm2 klasu simetrije. Fotografska dokumentacija tradicionalnih nošnji iz različitih etnografskih regiona prikupljena je i transformisana u pojednostavljene linearne prikaze radi klasifikacije simetrije. Ornamenti su analizirani prema utvrđenim principima simetrije, pri čemu je identifikovano prisustvo translacionog ponavljanja u kombinaciji sa vertikalnim i horizontalnim refleksijama ogledala, karakterističnim za pmm2 grupu. Među analiziranim primerima, bordurni ornamenti sa pmm2 simetrijom javljali su se često, naročito u dekorativnim elementima postavljenim duž rukava, izreza i rubova tradicionalnih odevnih predmeta. Njihova simetrična struktura doprinosi ne samo vizuelnoj harmoniji, već i funkcionalnoj stabilnosti tekstilnih elemenata. Studija ukazuje na značaj bilateralne simetrije u očuvanju kulturnog identiteta i pruža osnovu za savremeni tekstilni dizajn inspirisan tradicionalnim makedonskim ornamentima.

Ključne reči: bilateralna simetrija, granični ornamenti, makedonske narodne nošnje, pmm2 grupa, tradicionalni tekstil

1. INTRODUCTION

Traditional textile ornaments represent an important segment of the cultural and visual identity of many nations. Through the arrangement of motifs, colours and compositional structures, textile patterns preserve information about aesthetic values, regional traditions and symbolic meanings developed over centuries [1]. In Macedonian folk costumes, decorative textile elements occupy a significant place, combining artistic expression with functional and structural roles. Embroidered and woven ornaments are positioned on characteristic parts of garments such as sleeves, necklines, hems, aprons and belts, where they contribute to the visual balance and recognisability of the costume [2].

Among the different ornamental compositions found in traditional textiles, border patterns represent one of the most frequently occurring decorative forms. Border patterns are one-dimensional compositions created through the repetition of motifs along a single axis, usually between two imaginary parallel lines. Depending on the applied symmetry operations, these patterns may include translation, mirror reflection and rotational symmetry, resulting in seven primary classes of border symmetry groups [3].

Particularly significant among these classes is the pmm2 symmetry group, characterised by translational repetition combined with both vertical and horizontal mirror reflections. This type of bilateral symmetry creates visually balanced and rhythmically organised compositions, which are especially suitable for decorative applications on garment edges and structural textile elements. In Macedonian traditional costumes, pmm2 border patterns frequently appear in embroidery and woven decorations, contributing not only to the aesthetic harmony of the costume, but also to the reinforcement and visual framing of specific garment parts [4]. Symmetry analysis in traditional textiles represents an important methodological approach for understanding the structural organisation and visual



composition of ornamental patterns. Previous studies have demonstrated that geometric classification of textile ornaments can reveal relationships between decorative forms, cultural identity and design principles applied in traditional fabrics and embroideries [7,8]. In addition to their ethnographic significance, traditional textile patterns also serve as a valuable source of inspiration for contemporary textile and fashion design, contributing to the development of new decorative concepts based on historical motifs and compositional systems [5,6].

Therefore, the aim of this study is to analyse border patterns with pmm2 symmetry in Macedonian traditional textiles and folk costumes, with emphasis on their structural characteristics, frequency of occurrence and decorative role within the textile heritage of North Macedonia.

2. METHODOLOGY

The research was conducted through visual documentation and symmetry analysis of border ornaments found in Macedonian traditional textiles and folk costumes. Photographic material was collected from reproductions of traditional costumes used by national folklore ensembles, including Ensemble “Macedonia”, KAS “Ilinden” – Bitola, KAS “Ilinden” – Struga and KAS “Drimkol” – Vevčani, while an additional part of the material was documented at the Ethnological Museum in Skopje. The analysed ornaments originated from several ethnographic regions of North Macedonia, providing a representative overview of traditional decorative practices.

The selected ornamental samples consisted primarily of embroidered and woven border patterns positioned on characteristic garment elements such as sleeves, necklines, hems, aprons and decorative textile bands. From the collected photographic material, border ornaments exhibiting bilateral symmetry were identified and selected for further analysis. In order to facilitate the symmetry classification process, the original ornamental compositions were transformed into simplified linear black-and-white representations, allowing clearer identification of symmetry operations and repetitive structural elements. The classification procedure was conducted according to the geometric symmetry principles proposed by Washburn and Crowe [9], with emphasis on one-dimensional border symmetry groups.

The analysis focused specifically on the pmm2 border symmetry class, characterised by translational repetition combined with vertical and horizontal mirror reflections. Each selected pattern was examined in terms of the presence and arrangement of symmetry operations, motif repetition, compositional balance and structural organisation. In addition to the symmetry classification, observations regarding the decorative placement and functional role of the analysed ornaments within the garment structure were also considered.

The obtained results were comparatively evaluated in order to determine the frequency and visual characteristics of pmm2 border patterns in Macedonian traditional textiles, as well as their contribution to the aesthetic and cultural identity of folk costume ornamentation.

3. RESULTS AND DISCUSSION

3.1. Occurrence of pmm2 border patterns in Macedonian folk costumes

The conducted symmetry analysis included 22 border ornaments exhibiting pmm2 symmetry from Macedonian traditional textiles. The analysed patterns were characterised by translational repetition combined with vertical and horizontal mirror reflections, which are characteristic features of the pmm2 symmetry class. The results confirm the significant presence of bilateral symmetry in the visual organisation of traditional Macedonian ornamentation.

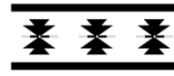
No.	Class (Region)	Sketch	Sample
a.	p'mm2 (2)		
b.	p'mm2 (2)		
c.	pmm2 (2)		

Figure 1. Examples of pmm2 border patterns identified in Macedonian traditional textiles

The analysed pmm2 border patterns were identified in several ethnographic regions of North Macedonia and appeared on different textile and garment elements, particularly on shirt sleeves, necklines, hems, aprons and decorative woven bands. Their frequent application on garment edges indicates both decorative and structural importance within traditional costume composition. In embroidered textiles, pmm2 patterns were often used to visually frame specific parts of the garment, creating balanced ornamental transitions between structural textile elements.

3.2. Structural characteristics of pmm2 symmetry

The pmm2 symmetry group is characterised by translational repetition combined with vertical and horizontal mirror reflections, resulting in highly ordered and rhythmically organised border compositions.

No.	Class (Region)	Sketch	Sample
a.	pmm2 (1)		
b.	pmm2 (5)		
c.	pmm2 (1)		

Figure 2. Linear reconstructions of a pmm2 border ornaments showing translational repetition and bilateral mirror symmetry

The analysed patterns demonstrated a clear repetition of ornamental motifs along a single axis, while the simultaneous presence of mirror reflections contributed to the formation of balanced bilateral structures.

In most examined examples, the motifs were geometrically stylised and arranged in repetitive sequences that generated visual continuity and compositional stability. The symmetry operations created a pronounced rhythmic effect, emphasising the linear character of the border ornament. In addition, the use of mirrored motifs contributed to the perception of harmony and regularity, which represents one of the defining visual characteristics of pmm2 border patterns. The characteristic symmetry operations of the pmm2 border group, including translational repetition and bilateral mirror reflections, are schematically presented in Figure 3.

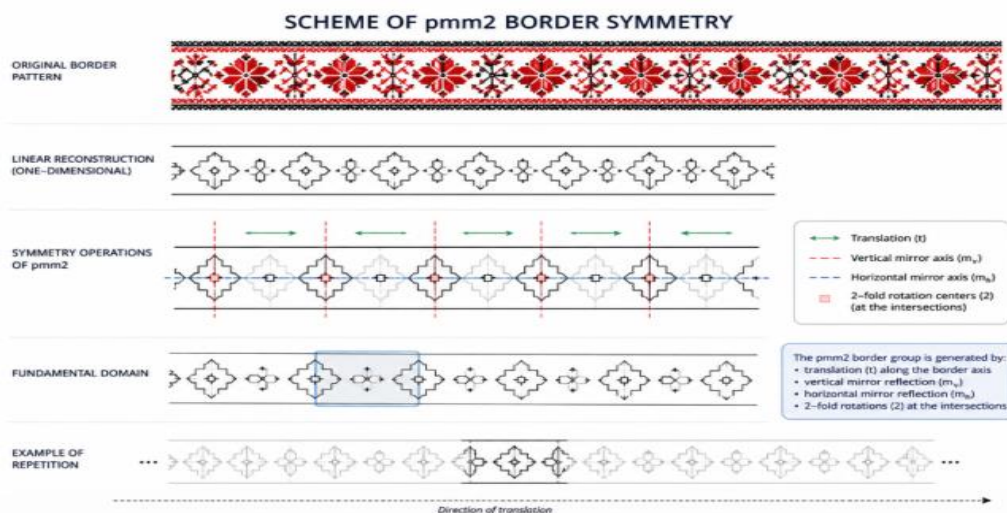


Figure 3. Symmetry operations characteristic for the pmm2 border group

Certain variations in motif size, internal decorative details and colour arrangement were also observed among the analysed samples. However, despite these minor visual modifications, the fundamental geometric structure of translational repetition combined with double mirror reflection remained preserved.

3.3. Decorative and functional role of pmm2 border patterns

Besides their decorative value, pmm2 border patterns also possess an important functional role within traditional textile constructions. Their placement on garment edges contributes to the visual definition and framing of structural clothing elements, while embroidered borders additionally reinforce textile areas exposed to frequent mechanical stress, such as sleeve endings and neckline edges.

No.	Class (Region)	Sketch	Sample
a.	p'mm2 (5)		
b.	p'mm2 (5)		
c.	pmm2 (4)		

Figure 4. Application of pmm2 border ornaments on characteristic elements of Macedonian folk costumes

The balanced composition achieved through bilateral symmetry enhances the visual harmony of the costume and contributes to the recognisability of traditional Macedonian textile ornamentation. The repetitive and geometrically organised structure of pmm2 borders also reflects the technical skills and aesthetic principles developed within traditional embroidery and weaving practices.

Furthermore, the analysed ornaments demonstrate the strong relationship between geometric organisation and cultural expression in traditional textiles. Through the preservation and transmission of ornamental structures across generations, pmm2 border patterns became an integral part of the visual identity of Macedonian folk costumes.

3.4. Relevance of pmm2 symmetry for contemporary textile design

Traditional border ornaments continue to represent a valuable source of inspiration for contemporary textile and fashion design. The geometric clarity, rhythmic repetition and balanced structure characteristic of pmm2 symmetry provide possibilities for reinterpretation within modern decorative compositions, woven structures, printed textiles and fashion applications.

The study of traditional symmetry systems contributes not only to the preservation of cultural heritage, but also to the development of innovative design solutions derived from



historical ornamental principles. In this context, pmm2 border patterns represent an important connection between traditional textile heritage and contemporary design practices.

4. CONCLUSION

The conducted study confirmed that border ornaments with pmm2 symmetry represent one of the most dominant and visually characteristic decorative structures in Macedonian traditional textiles and folk costumes. The analysed patterns demonstrated a consistent application of translational repetition combined with vertical and horizontal mirror reflections, resulting in balanced and rhythmically organised ornamental compositions. The frequent occurrence of pmm2 border patterns on garment edges, sleeves, necklines and woven decorative bands indicates both their aesthetic and structural significance within traditional textile constructions. Besides contributing to visual harmony and compositional balance, these ornaments also reflect the cultural identity and traditional craftsmanship preserved through generations.

The obtained results demonstrate that symmetry analysis represents an effective methodological approach for the classification and interpretation of traditional textile ornaments. Furthermore, the geometric organisation and decorative principles of pmm2 border patterns may serve as valuable inspiration for contemporary textile and fashion design based on traditional cultural heritage.

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