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Geometric Harmony: A Symmetry Analysis of Motifs in Rabha Traditional Textiles

ABSTRACT

This research offers a design-focused analysis of symmetry in the traditional textile motifs of the Rabha community in Assam, India. It investigates the function of symmetry—as both an aesthetic and structural principle within Rabha weaving traditions, emphasizing motifs, visual forms, and spatial arrangements through symmetry analysis. Employing a qualitative, visual-analytical approach grounded in ethnographic fieldwork and mathematical symmetry theory, the research identifies and classifies motifs according to their visual attributes, symmetry operations, and compositional principles. The findings show that the main types of symmetry observed in Rabha textiles are reflection and translation symmetry. Floral and ritual motifs commonly exhibit rotational symmetry. These symmetrical designs reflect the Rabha people's understanding of the universe as balanced and harmonious. They also demonstrate the close relationship between cultural beliefs and visual organization. The study highlights that indigenous craft traditions, such as Rabha traditional textile motifs, are not only decorative but also reflect complex mathematical thinking and aesthetic principles. This research enhances the domain of indigenous design studies by offering a framework for comprehending traditional textile design systems through the amalgamation of mathematical logic, visual forms, and their compositional structure.

Keywords: Rabha textiles, symmetry analysis, indigenous motifs, social design, visual ethnography.

1. Introduction

The Rabha are one of the oldest indigenous communities of Assam. They are also known as *Bhumi Putra*, meaning "Son of the Land." The Rabhas are a well-known indigenous community in Assam. They are an ethnic group with a long and rich cultural history (Sarma H. , 2008). People have always migrated from one place to another in search of better opportunities and improved living conditions. Assam, known for its natural beauty, has attracted people from different parts of the world over time. Various ethnic groups have arrived in Assam through different historical processes, and each group has contributed its own culture, traditions, and identity to the region. They found the place extremely beautiful and chose to settle there permanently, which led to lasting changes in the local culture. A. Playfair, a British colonial administrator and ethnographer, believed Rabhas migrated from that Tibet region to Garo Hill and later spread out to different parts of Assam plain regions (Bordoloi, Thankur, & Saikia, 1987). The region is characterized by linguistic and cultural diversity, as people living in both hill and plain areas speak different languages and follow varied cultural practices. This diversity enhances the uniqueness of the region. The Rabha

community inhabits both the hill and plain regions of Assam, reflecting this cultural and geographical diversity. They have a long and interesting history of social and cultural life, with their own language, literature, culture, and customs. Their culture comprises oral literature, traditional clothing (figure 1), jewellery, weapons, religion, ceremonies and rituals, performances, festivals, musical instruments, and more (Sarma H. , 2008). Assam is in the centre of northeast India and is home to people from many different ethnic groups. According to the 2011 census and a report from the Government of Assam, there are 296,189 Rabha people. Rabha society is governed by customs, traditions, and religious beliefs. *Pati* Rabha, who are assimilated in mainland Assamese culture and worship Hindu gods and goddesses. *Rongdani* and *Moitori* Rabha celebrate *Baikho or Khoksi* puja festival to propitiate *Baikho,* the Goddess of wealth (G.C.Kakoti, 2007). The Rabha women are very skilled weavers. They produce garments for family members using traditional looms. (Sarma L , 2021).

Fig. 1. Rabha costume. Photograph by the author from *Dudhnoi* (Assam) (2023).

A motif refers to a repeated visual element, while a pattern is the organized repetition of such elements (Musa, 2019). Textile designs and motifs hold deep symbolic significance, representing the heritage, beliefs, and cultural expressions of a community (Bori & Neog, 2017). In everyday conversation, the terms “motifs” and “design” are often used interchangeably, sometimes referring both to a single element and to the overall composition. However, these terms have more specific meanings in academic contexts. In textile studies, “design” generally refers to the organized arrangement of motifs and patterns in a structured and systematic manner. The placement and arrangement of motifs play an important role in increasing the value and appeal of textiles. Many people prefer traditional fabrics with decorative designs rather than plain ones. Therefore, motifs are essential in traditional textiles, as they enhance their visual attractiveness while also contributing to their cultural significance and commercial value. More so in the Rabha community, as these designs(figure 2) are significant in material culture and have a deep meaning among the community and its people. Motifs also represent the community’s visual identity to the world.

The study of indigenous textile traditions serves both as an exploration of material culture and as a way to understand the lived experiences, values, and identities of the communities that produce them.

Fig. 2. Motif and pattern of Rabha textile. Photograph by the author from *Amguri* (Assam) (2023).

Symmetry is one of the fundamental principles of design and can be observed in nature, art, and human-made objects. The Rabha community of Assam has developed a distinctive textile language rooted in the traditional weaving practices of Northeast India. A key characteristic of this textile tradition is the use of symmetrical patterns. Rabha weavers create their designs by drawing inspiration from their everyday experiences, surrounding environment, and cultural symbols. They generally use geometric shapes like triangles, diamonds, chevrons, and zigzags in their visual language, and they regularly arrange them in symmetrical patterns.

The Rabha motifs, produced using traditional backstrap and throw-shuttle looms, demonstrate a strong understanding of geometry and visual balance. This suggests that the artisans possessed advanced practical knowledge and aesthetic skills, even without formal training in mathematics or design.

This research examines these designs through a comprehensive framework of symmetry analysis developed by M. A. Hann (Hann M. A., 2003). This study undertakes a detailed symmetry analysis of Rabha textile motifs, analysing the impact of reflection, rotation, translation, and glide reflection transformations on their visual organization and cultural significance. This study categorizes motifs into symmetry types: Dihedral (Dn), cyclic (Cn), and asymmetric (As), and examines their distribution among motifs categories—geometric, floral, zoomorphic, and abstract. It employs a visual-analytical and interpretative framework grounded in ethnographic observation to demonstrate that symmetry in Rabha textiles transcends mere aesthetic embellishment. It is a collection of symbols that represent the community's beliefs in social balance, peace, and continuity.

This study aims to clarify the relationship between symmetrical organization in Rabha motifs and indigenous expressions of order, balance, and continuity, which form the basis of geometric order and motifs typology in Rabha textile patterns through the utilization of mathematical classifications on documented motifs.

2. Literature Review

In textile studies, symmetry analysis has been widely used as a systematic tool to understand the underlying visual order, structural logic, and cultural meaning embedded in motifs and patterns. Research in visual insight and decorative design demonstrates how symmetry operations such as translation, reflection, rotation, and glide symmetry structure frieze patterns and influence aesthetic judgement by making pattern organization perceptually legible (Friedenberg, Martin, Uy, & Kvapil, 2022). Computational and image-based studies further extend this approach by using symmetry group theory to decode mosaics and Islamic geometric patterns, extracting lattices, object classes, and wallpaper groups to understand pattern construction and repetition (F.Albert, 2014). Within textile-specific contexts, symmetry has been applied to analyse historical silk fabrics and reconstruct damaged motifs through axial symmetry, demonstrating its value for conservation and design interpretation (Mar Gaitán, 2020). Design theory research emphasizes symmetry as a transferable analytical language across cultures, capable of explaining how motifs are generated from geometric rules rather than surface appearance alone (Hann & Thomas, 2007). Ethnographic and textile studies similarly use plane symmetry and repetition to interpret carpets, indigenous weavings, and traditional textiles as structured systems governed by mathematical order rather than decorative intuition (Bier, 1992): (Chudasri & Sukantamala, 2022): (Liang, 2025). Collectively, these studies confirm that symmetry analysis enables a deeper understanding of motifs arrangement, repeat structures, and cultural pattern logic, thereby supporting the adoption of M. A. Hann's symmetry classification method as a rigorous and culturally sensitive framework for the systematic study of textile motifs and pattern structures (Hann M. A., 2003).

3. Methodology

3.1 Research Design

This study uses a qualitative, visual-analytical research design that incorporates ethnographic fieldwork, design analysis, and mathematical symmetry classification. The methods combine documentation of indigenous textile motifs with analytical tools drawn from geometry and pattern theory proposed by M. A. Hann, enabling a systematic understanding of structurally embedded symmetry in Rabha textiles. The approach allows for the structured examination of motifs as both geometric structures and cultural artefacts.

3.2 Study Area and Sampling Strategy

Fieldwork was conducted in five Rabha-inhabited villages in Assam-*Dudhnoi, Amguri, Nadiya Para, Boko,* and *Chaygaon*, where traditional throw-shuttle loom practices continue in everyday weaving traditions. Another reason for selecting these locations was the presence of expert weavers who possess intergenerational knowledge of motifs. In these areas, both ritual and everyday textiles continue to incorporate traditional motifs and patterns. This combination ensured access to authentic motifs traditions.

3.3 Data Collection Methods

During fieldwork, high-resolution photographs of textiles, border designs, and various motifs and patterns were collected as the main method of primary documentation. To ensure accuracy, all images were taken from fully constructed garments that were either worn or preserved by Rabha households, allowing the motifs to be observed in their original functional context. The study identified a total of 91 traditional Rabha textile motifs.

3.4 Digitization of Motifs

All 91 documented motifs from the field visits were vectorized using Adobe Illustrator software. Digitization enabled the extraction of precise linear structures, the removal of distortions caused by folded or aged fabrics, the standardization of motifs dimensions, and the preparation of motifs for geometric and symmetry analysis.

3.5 Motifs Classification and Categorization

The process of categorizing motifs is essential for a structured and systematic study of these elements. According to cognitive categorization theories (Athavankar, 1989), human perception naturally groups objects based on similarities. Categorizing motifs helps scholars and designers quickly recognize patterns and understand their meanings. Formal categorization was a critical step in the analytical process, enabling efficient organization of collected motifs into coherent groups based on visual characteristics and thematic relevance (Deori, 2022) ; (Das, De, & Singha, 2020). Each extracted motifs was classified into one of the four primary visual categories based on design elements and theme.

Geometric motifs

These motifs are usually repeating, very structured, and generally used as border elements or framing techniques in the textile layout(figure 3). Regular polygons, symmetrical patterns, and angular shapes, including diamonds, chevrons, and zigzags, are used to define them (Jones, 1856); (Gillow & Sentance, 1999); (Hutton, 1921).

Fig. 3. Geometric Rabha Motifs. Photograph by the author from *Boko* (Assam) (2024).

Floral Motifs

These motifs are inspired by plants, including leaves, flowers, and creepers (figure 4). They stand for fertility, growth, and natural beauty. They are usually curvy and can be placed in the middle or in symmetrical patterns (Goswami, 1993); (Dhamija, 1979); (Harris, 2010).

Fig. 4. Floral Rabha Motifs. Photograph by the author from Guwahati University anthropology museum (2024).

Zoomorphic motifs

These motifs are inspired by animals, birds, and insects(figure 5). They are relatively simple in their visual representation but have a very distinct style (Elwin, 1959); (Hutton, 1921); (Dhamija, 2004).

Fig. 5. Zoomorphic Rabha motifs. Photograph by the author from Guwahati University anthropology museum (2024).

Abstract motifs

These motifs are not meant to represent anything, but they are based on cultural customs, ceremonial symbols, and intuitive artistic interpretations(figure 6). They often have an experimental form and have spiritual or mythical meanings. These Motifs have lots of strong significance in the community (Gombrich, 1979); (Arnheim, 1974).

Fig. 6. Abstract Rabha Motifs. Photograph by the author from *Nadiya Para* (Assam) (2024).

This classification offers a systematic framework for recognizing the visual forms and patterns of traditional Rabha textile motifs. It will be further analysed to understand its relationship with symmetrical patterns, with the aim of improving our understanding of the visual features of Rabha textile motifs and designs.

After categorizing the 91 motifs that were documented for study, the following numbers were found in each category.

Table 1. Motifs in each category

Geometric motifs	44
Floral motifs	22
Zoomorphic motifs	18
Abstract motifs	7
Motifs Category	Total

3.6 Symmetry Analysis Framework

Symmetry theory offers a structured way to understand patterns in indigenous motifs. Following M. A. Hann, a design scholar from the University of Leeds known for his work on pattern and symmetry (2003), symmetry is seen not just as a visual feature, but as a way communities express cultural order, spatial thinking, and ritual meaning through design.

M. A. Hann's symmetry analysis

Symmetry, an important feature of textile design, was analysed to better understand the structure of the compositions. By examining patterns and motifs, viewers can see how the designs are organized and constructed. To analyse the symmetry of traditional Rabha textile motifs and patterns through categorization methods focused on their symmetrical characteristics, as described by M. A. Hann, is employed in *Conceptual Developments in the Analysis of Patterns*. This method allows motifs and patterns to be studied in an organized way by breaking them into simple geometric pieces and variations in symmetry operations. Hann was among the earliest scholars to analyse patterns within a scientific and mathematical framework. Woods showed people how designs may be symmetrical, especially in fabrics. He authored a lot of papers for the *Journal of the Textile Institute* (1935, 1936) that helped people understand how to make designs using geometry. Talked about symmetry in flat patterns, such as counter change symmetry, and how to put items in a logical order. Later, Washburn and Crowe (1988, 1989) created a book called "*Symmetries of Culture: Theory and Practice of Plane Pattern Analysis*." This book delved into further detail on how symmetry may be employed in cultural settings. M. A. Hann was the most essential person who helped come up with the idea. It looks at how symmetry-based pattern analysis has changed over time and how it could be used in textiles.

These researchers jointly advanced the systematic exploration of motifs and patterns, introducing methodologies that have become crucial in the examination of motifs and designs in both historical and present contexts. This analytical approach facilitates a comprehensive and impartial analysis of the structural attributes of motifs in traditional Rabha textiles.

Motifs analysis

Motifs can be classified into two main types: symmetrical and asymmetrical. Symmetrical motifs can be further divided into two groups, Cn and Dn, based on the types of symmetry operations they exhibit, such as rotation and reflection.

Cn motifs exhibit *n*-fold rotational symmetry, meaning the motifs rotates around a central point *n* time within a full turn. For example, see Figure 7.

Fig. 7. Cn motifs symmetry

Dn Motifs, which are motifs that combine rotation with one or more reflection axes.

Put together n-fold rotational symmetry and n reflection axes. For example, Figure 8.

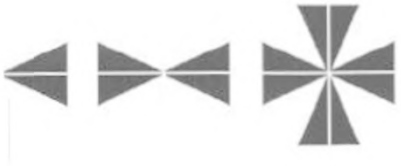

Fig. 8. Dn motifs symmetry

Asymmetrical motifs do not have symmetry operations.

4. Result

4.1 Symmetry analysis of Motifs

Organizing Rabha textile motifs symmetrically inside the M. A. Hann framework reveals distinctive aesthetic and structural tendencies that reflect the community's design sense. The research identifies three primary categories of symmetry: Dihedral (Dn), Cyclic (Cn), and Asymmetric (As). The number of motifs in each category, along with the corresponding characteristics of each category, are presented in the table below.

Table 2. Categories of symmetry

Symmetry Type	Code	Number of Motifs	Design Traits
Dihedral	Dn	72	Balanced, mirror and rotational symmetry
Cyclic	Cn	7	Radial/rotational symmetry only
Asymmetric	As	12	No symmetry; organic or narrative

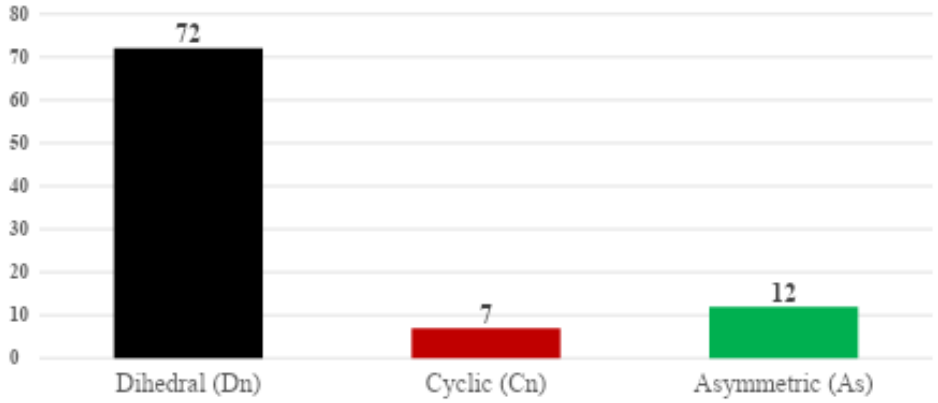

Fig. 9. Symmetry Analysis of Rabha Motifs

Interpretation

The fact that Rabha textile patterns often incorporate Dihedral (Dn) suggests that balance, order, and harmony are vital to their culture. This is seen in structured, repetitive, and reflective designs that create rhythmic patterns, evoking a sense of stability and continuity. In contrast, asymmetric designs intentionally disrupt regular patterns. This allows them to stand out within largely symmetrical compositions and makes them visually more engaging. Rabha textiles are mostly based on balance, visual rhythm, and symbols.

They create both aesthetic appeal and cultural expression through the use of repeating geometric shapes, interlocking structures, and symmetrical modules. These visual features suggest the use of traditional looms, which naturally favour symmetrical designs due to the counted warp and weft structure. They also show a design system that is both mathematical and highly symbolic, where cultural meaning and geometric perfection come together.

The motifs[1] combine elements from nature, ceremonial life, and identity, reflecting the distinctive characteristics of Rabha weaving traditions. These traditions integrate skilled craftsmanship with spiritual meaning, demonstrating both technical expertise and cultural expression.

Among the 91 motifs, 72 (79.1%) exhibit dihedral symmetry (Dn), 7 (7.7%) cyclic (Cn), and 12 (13.2%) asymmetries (As). This distribution indicates a strong structural preference for bilateral and rotational balance, aligning with the technical constraints of shuttle hand–loom weaving, which naturally favours mirrored patterning.

4.2 Symmetry Analysis of Rabha Motifs Based on Motif Types

Table 3. Symmetry Classification by Motifs Type

Motifs Type	Dn (Dihedral)	Cn (Cyclic)	As (Asymmetric)	Total
Geometric	41	2	1	44
Floral	13	4	5	22
Zoomorphic	12	1	5	18
Abstract	6	0	1	7

[1] Some of the significant motifs from Rabha community are listed the annexure.

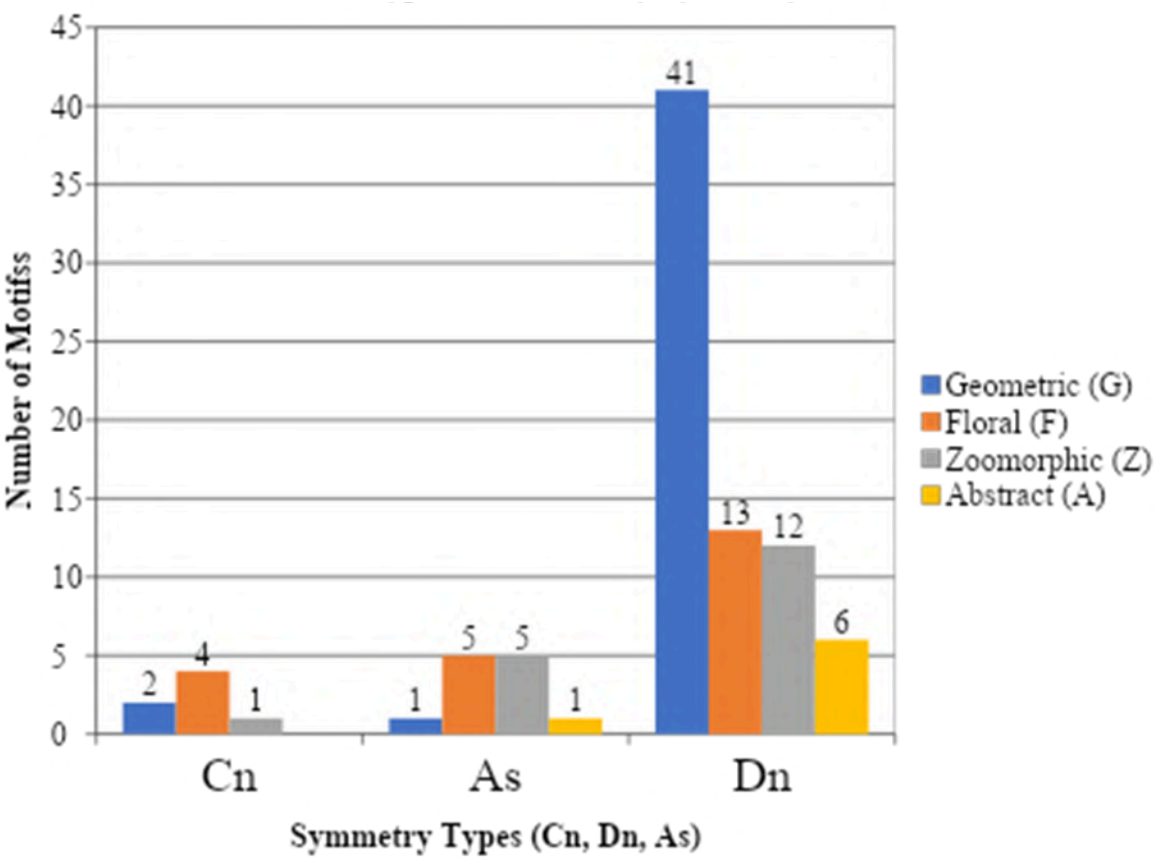

Fig. 10. Motifs Type Distribution by Symmetry Class

Here is a bar graph that shows how different types of motifs (Geometric, Floral, Zoomorphic, Abstract) fit into their symmetry categories (Dn, Cn, As).

4.2.1 Dominance of Dihedral Symmetry (Dn)- Highly Symmetrical Structures

Table 4. Dihedral Symmetry (Dn)- motif types

Motif Types	Number of Motifs
Geometric	41
Floral	13
Zoomorphic	6
Abstract	12
Total Motifs	72

Interpretation

The most prominent type of symmetry in the corpus is dihedral symmetry (Dn), which encompasses both reflection and rotation. This high frequency is in line with the geometric accuracy that is

common in Rabha border and body designs. The use of Geometric motifs in textile design shows a typical drive toward balance, order, and clarity. Floral motifs in this group still have a mirrored balance, and they are commonly utilized in patterns that go all the way across the fabric. Structural constraints of the throw shuttle hand loom, which naturally favour mirrored repeats.

4.2.2 Cyclic Symmetry (Cn) - Radial and Central Balance

Table 5. Cyclic Symmetry (Cn)- motif types

Motif Types	Number of Motifs
Geometric	2
Floral	4
Zoomorphic	1
Abstract	0
Total Motifs	7

Interpretation

Cyclic symmetry is most observed in floral or radiating patterns. This is why it is the most common type of symmetry for flower designs (4 out of 7). Most of the time, these designs are found in the middle of the cloth or in the most important parts, such as the shoulder or *pallu*. Using Cn symmetry is a design choice that makes objects look complete and centred.

4.2.3 Asymmetric Motifs (As)- Expressive and Figurative Forms

Table 6. Asymmetric (As)- motif types

Motif Types	Number of Motifs
Geometric	1
Floral	5
Zoomorphic	5
Abstract	1
Total Motifs	12

Interpretation

In Rabha textile design, asymmetrical motifs are used selectively when required. It usually has zoomorphic or narrative elements or shapes that narrate stories. The deliberate absence of symmetry disrupts visual rhythm and makes the motifs stand out. Asymmetric motifs are often used to make a

point rather than to repeat a pattern. They can be seen in panels or certain locations. Asymmetry motifs are only employed when required to create a contrast to the symmetric mirrored motifs and geometric rigidity of border patterns.

5. Conclusion

This study contributes to design studies by offering a structured way to analyze traditional motifs through geometric principles. It focuses on examining their shapes and spatial organization. It also suggests that symmetry is not only used for aesthetic purposes, but also serves as a form of visual communication that expresses the cultural values and perspectives of a community. The fact that most motifs have dihedral symmetry (Dn) reveals that people respect equilibrium in society. This fits with the Rabha style of thinking on how to link nature, society, and spirituality. These patterns exhibit mirror symmetry and are evenly spaced apart. They exhibit technical competence and the structural correctness that comes with traditional handlooms. On the other hand, using cyclic (Cn) and asymmetric (As) compositions meticulously in floral, zoomorphic, and abstract patterns makes the textile design more varied and appealing. Cyclic symmetry makes floral patterns look full and centred, while less common asymmetry makes the patterns look deeper, especially when they are used to tell stories or have ritual meanings. Rabha textile symmetry is a mix of artistic discipline, technical knowledge, and symbolic communication. It displays how traditional weaving can put thoughts about harmony, rhythm, and identity into visuals. This indicates that Rabha textiles are both beautiful works of art and a way to learn about the culture. They use a unique design approach from their own culture that links geometry and meaning.

This study contributes to design scholarship by presenting a replicable methodology for analysing indigenous textile motifs through symmetry theory. It highlights the need to preserve and document such systems as part of India's cultural and design heritage. Future research could enhance comparative evaluations of tribal textiles from Northeast India by employing digital pattern-recognition tools to computationally represent indigenous geometry. These kinds of methodologies would highlight how advanced historical weaving systems are and help them enter modern design curricula.

6. Limitation of The Study

The study faced several constraints that may have influenced its outcomes. First, access to older or archival garments was limited, restricting the ability to conduct a comprehensive historical comparison of motifs evolution. Additionally, some degree of bias may be present due to contemporary adaptations incorporated by weavers, which could differ from traditional practices. The analytical scope was also confined primarily to surface-level examination of symmetry and structural arrangement**,** without extending into related factors such as color theory, variations in weaving tension, or material-specific constraints. These omissions narrow the depth of technical analysis and point to areas that future research could address more fully.

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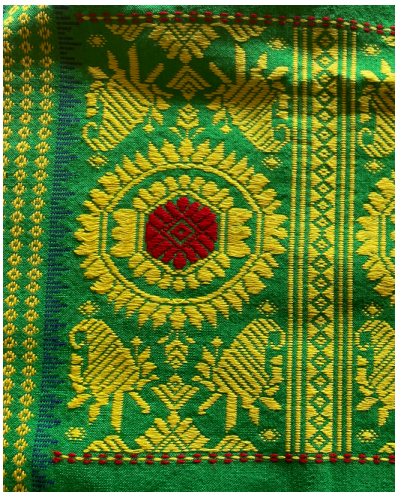
Annexure-Some of the significant motifs of Rabha community[2].

Garai phong khap

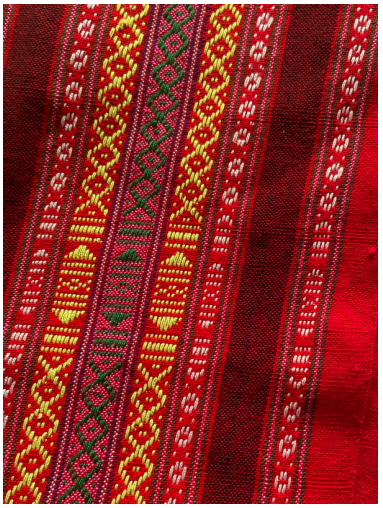


Bai Paar

katshi pha

Zignata

Khodobung Paar



Toh Paar

[2] All images were photographed by the author in Assam and Meghalaya during 2023–2024.

Rang San Paar

Boa Paar

Thopa Paar