

Sensory Reconstruction Design Using Local Materials in Urban Renewal: A Case Study of the Reuse of Waste Bricks and Rubble in the Deji Alley Urban Renewal Project in Ningbo

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Abstract: Demolition and relocation of Chinese cities produce considerable construction waste, and old bricks and tiles, as well as the community's memories attached to them, are often discarded, resulting in a loss of place identity. This paper explores the sensory resources in local waste materials and proposes the concept of sensory and material reconstruction based on tactile, auditory and visual experiences. Based on the above research, this paper studies the renewal project of the Deji Alley Historic and Cultural District in Ningbo. Post-completion surveys, sensory attribute tests and user interviews were carried out at some material-reuse sites. The four material-reconstruction strategies in this paper are stacking, collage, vertical masonry and cage-filling. Findings reveal that the original traces retained on reclaimed materials serve as distinctive sensory resources that evoke residents' place-based memories. Moreover, the four strategies require no specialized equipment and are readily applicable to micro-renewal projects in older communities. This study offers a low-cost, low-carbon, and human-centered approach to material reuse in urban renewal.

Keywords: Urban renewal; Local waste materials; Sensory reconstruction; Material grammar; Sense of place

Online publication: Oct 13, 2026

1. Introduction

1.1. Research background

As China's urban development enters a phase of renewal of the existing urban stock, large-scale demolition and relocation associated with urban renewal have improved living conditions while also generating substantial volumes of construction waste. According to statistics from the Ministry of Housing and Urban-Rural Development, China generated approximately 3.5 billion metric tons of construction waste in 2022,

of which more than 40% was reportedly associated with urban renewal and demolition activities. But the percentage of recycling and reuse is less than 10% and much less than the figures given by some countries (70–90%), as it is not yet high enough to be considered as high as possible. The costs of transportation and landfill disposal are estimated to reach up to CNY 100,000 to remove the waste that has been left behind after the demolition of every 10,000 m² built-up area. Meanwhile, there are old bricks, tiles, and slabs of bluestone used by the community to remember the community, which are cleared off and substituted with granite paving, aluminum windows and doors, and pressure-treated wood benches. This results in making the city homogenized and the local identity and sense of place eroded. To those who have lived in the region for a long time, the new environment can become alienating, and the material remains of the memories of generations may be forgotten.

Christian Norberg-Schulz is one of the most prominent theorists of architectural phenomenology, and he believed that a place is not just an object, but also has a *genius loci*, or a character, which is the spirit of the place. The presence of such objects can be seen in the fact that when they are completely removed, it would have been difficult to create a new identity of a place by using the old materials. The quality of open space in cities is also becoming more focused on as urban renewal projects are being implemented with the focus on regenerating the existing neighborhoods rather than creating new ones. The role of open spaces of the city should be taken into consideration not only as a part of the city environment, but also as the space where the local population remembers its own history and preserves its identity. The state of urban public open spaces is quite important because it contributes to the image of the city and the life quality of its citizens. In the context of the reproduction of the urban space, the process of urban renewal does not necessarily mean the restoration of the urban space itself, but the creation of social relations and the distribution of their benefits.

1.2. Research objectives and significance

This study aims to develop design methods for the sensory reconstruction of locally-sourced reclaimed materials in urban regeneration, addressing two deficiencies in contemporary material reuse practices: a focus on material attributes at the expense of sensory experience, and a preference for visual qualities over tactile engagement. This paper has three specific aims. First, an analytical system will be established to describe and evaluate the tactile, auditory and visual sensory characteristics of reclaimed materials, thus complementing engineering-driven mechanical-property research and vision-centered landscape design. Second, it establishes a material-reconstruction grammar of practical, replicable strategies based on field investigations of the completed Deji Alley project, such as stacking, collage, vertical masonry and cage-filling. Each strategy has a particular sense of perception: touch, sound, light and shadow, etc. Third, based on the “Tactile Memory” project in Deji Alley, after the project, post-project surveys, sensory evaluations and user interviews were conducted to explore how the sensory qualities of reclaimed materials shape place memory, and it was investigated whether locally sourced materials with original textures and traces trigger residents’ site-related memories and emotional attachments.

The two types of theoretical contributions are: First, it expands the scope of application for spirit-of-place theory in practice by transforming its conceptual ideas into a material-oriented design approach. Christian Norberg-Schulz’s phenomenological theory proposes a “character” for place identity but provides little methodological guidance on its material application. Through the intermediate concept of sensory reconstruction, this study operationalizes abstract place character into a usable material grammar and

provides a methodological path for phenomenology-oriented design research. Second, it adds an experience-based definition of sustainable design. Existing sustainable-design scholarship prioritizes quantifiable metrics such as carbon output, recyclability and material lifecycles while neglecting user sensory experience. This paper proposes that the concept of sustainability should also include waste reduction and tactile-auditory material experience, integrating material recycling with cultural experience. Practically, the research benefits three urban-renewal stakeholder groups. It offers designers a small-scale, low-technology tool set. The four reconstruction methods do not require special equipment and can be carried out by masons using wire mesh and cement mortar for budget-limited micro-renovation of old areas. Local people can join in waste-material identification, collection, and sorting, create community-accessible designs, and foster a sense of collective ownership. Urban authorities can reduce transport costs, landfill pressure, and carbon emissions at the source to protect the community's memory and social cohesion. Provide evidence-based alternatives to traditional waste disposal for construction waste governance.

2. Literature review

2.1. Current state of domestic research

Recently, research at home on material reuse in urban renewal has been developing rapidly. From an engineering standpoint, Jin Jiangying (2026) has shown that reclaimed brick and tile materials are technically feasible, with a compressive strength of 18 MPa, 32% lower thermal conductivity than traditional clay bricks, and a 72% solid-waste utilisation rate ^[1]. Fan Tiankui (2026) and Tang Huifang (2026) have examined the system of China's urban renewal policies at the institutional and policy levels and proposed strengthening the top-level design and multidimensional evaluation system ^[2,3]. In terms of social-risk governance, Li Qiong (2026) and Zhang Zimeng (2026) have used social network analysis to study the development of actual risk, perceived risk and strategic behavior in Shanghai's old-city renewal, and pointed out that perceived risk is central to group polarization and residents' behavioral responses ^[4,5]. Tang Yan and Hao Ting (2026) studied the implementation of sustainability through the "Shanghai Shangshengxin" project and provided research methods for this study. Wang Weili et al. (2023) proposed using recycled materials as physical catalysts for incremental activation of old urban spaces in the field of renewal design strategies ^[6]; Wu Yi et al. (2026) developed five strategic categories for existing bridge landscape renewal ^[7]; Liu Wanhua (2026) put forward three principles for industrial heritage residential renewal that emphasize the retention of spatial context and functional improvement; and Yan Jing and Zhang Tiantian (2026) applied the Analytic Hierarchy Process to evaluate social restoration results in Suzhou Old City ^[8,9].

In short, all these studies have expanded the knowledge base in many areas: optimization of material performance, institutional construction, social risk management, sustainable design, catalytic renewal, infrastructure renovation, heritage protection and assessment methods. However, a serious deficiency still exists: in engineering, policy, risk governance and spatial planning, most of the discussions have focused on the "material" side—improving durability, standardizing processes, resolving social conflicts and enhancing sustainability—and have paid little attention to the sensory experience of reclaimed materials on people's bodies.

Internationally, the conscious reuse of reclaimed materials in architecture can be traced back to the mid-20th century, and Carlo Scarpa's renovation of the Verona Castle Museum is a typical case. Scarpa embedded damaged stone fragments in the new floors and walls, using a "display-oriented" method to turn ruins into

readable historical materials and prompting later generations to focus on displaying rather than hiding waste materials. Zhang et al. (2026) used spatial syntax to enhance the function of historic districts and optimize pedestrian and bicycle systems, providing quantitative support for waste reuse design^[5]. Qin et al. (2025) considered the problem of multi-stakeholder governance and proposed institutional design that balances the demands of residents, public interests and efficiency to achieve renewal^[10]. Together, these foreign studies have provided a strong interdisciplinary foundation for historic district renewal and material reuse, but they have also failed to address the sensory dimension that this paper aims to explore.

3. Shortcomings of existing research

Based on the above review, the existing research has three main deficiencies. First, existing research remains predominantly engineering-oriented, with limited attention to sensory experience. Current research on the reuse of construction waste is largely concentrated in engineering and technical fields such as material mechanics, mix design, and durability testing. Research in the field of design studies is relatively weak and primarily focuses on visual aesthetic analysis (color, texture, form), while systematic research on bodily senses such as touch and hearing remains virtually nonexistent.

Second, existing research emphasizes macro-level strategies while providing limited guidance at the methodological and operational levels. When discussing the reuse of waste materials, existing literature often remains at the level of advocating that “reuse should occur” or presents “portfolio-style” showcases of case studies, while providing limited operational guidance on how reclaimed materials can be reused in practice. When faced with a pile of waste materials, designers lack methodological tools that can be referenced, combined, and critically evaluated.

Third, visual-centrism dominates evaluation criteria. Current practices evaluate designs using reclaimed materials primarily in terms of their visual effects, including aesthetic appeal and formal coherence. There is a lack of systematic assessment methods and evaluation criteria for the user’s physical experience (such as whether it is comfortable to sit on, whether it makes noise when walked on, or whether it feels cool to the touch).

According to the above weaknesses, this research will help in the following aspects: treating the topic in a sensory aspect, simplifying action-oriented reconstruction syntax, and relying on body experience as the evaluation point. This view should not be seen as a substitute of engineering studies of reclaimed materials or studies of visual aesthetics but it is supposed to complement them in the dimension of the sensory-bodily.

4. Research subjects and methods

4.1. Research site

This research chose the Deji Alley Historical and Cultural Block Renewal Area in Jiangbei District, Ningbo City, Zhejiang Province as the case study site. Deji Alley was constructed in the late Qing dynasty and early Republic of China era, and it is one of the best-preserved traditional alley communities in the old city of Ningbo, with a total area of about 1.2 ha. The area preserves a large number of traditional residential houses built from the late Qing dynasty to the Republic of China era, featuring blue-gray bricks, black tiles, Shikumen gatehouses, and wooden structures. In 2023, this area was included in the pilot project of old urban area renovation and micro-renovation in Jiangbei District. It plans to renovate public space in the partially

collapsed courtyards and idle corner plots while retaining the main structure of historical buildings.

During the renewal process, the demolition of illegal structures and some dilapidated buildings generated a large amount of construction waste. In March 2024, the research team conducted a systematic collection, sorting, and statistical analysis of the on-site waste. The results showed that the total volume of debris was approximately 62 metric tons. Of this, intact or partially intact blue bricks ($240 \times 115 \times 53$ mm) accounted for about 35% of the total; fragments of red bricks accounted for about 20%; fragments of small blue roof tiles and cylindrical roof tiles accounted for about 18%; broken ceramic tiles (primarily from old kitchens and bathrooms) accounted for about 10%; concrete fragments accounted for about 12%, and other mixed waste accounted for about 5%. Notably, the surfaces of a large number of bricks and tiles retained their original traces: the blue bricks showed traces of mortar, soot-stained black spots, and signs of weathering and spalling; moss grew on the surfaces of the roof tiles, and their edges showed chips and chips; some broken ceramic tiles still retained their blue-and-white patterns. These are the main sources of material that will be used in the future sensory design.

It must be noted that the paper is a retrospective research study and not a design practice. The project of the actual renewal of the area of Deji Alley was contracted by the Jiangbei District Housing and Urban-Rural Development Bureau of Ningbo City, and the author of this work did not take part in the design or building process of the project itself. Rather, as an independent scientist, the researcher conducted the field survey, material testing, sensory examination, and interviews with the users after the completion of the project (May 2026) to gain general knowledge about the design and methodology of current practices.

4.2. Research methods

This paper is a case study in nature that will involve the analysis of the subject matter, field research, and sensory evaluation, as well as interviews with the users. It involves a literature review of the domestic and foreign literature on architectural waste reuse, place memory, and sensory design, which is necessary to understand the essence of local waste and the concept of reconstruction of the senses, to identify the existing gap in knowledge, and to create the theoretical basis. The survey was then done in the field after the Deji Alley project had been completed, where the materials of the waste were documented by photographing them, categorizing them, estimating their quantity, and how they are distributed in space in terms of location, density, and availability of every node. Moreover, the dimensions, color, integrity, and surface marks of the waste were also recorded. This would be an initial dataset of this survey to conduct further sensory studies and to formulate the grammar of material reconstruction.

The analysis is the core of the project, which includes the case study of four waste nodes already constructed, namely a cage wall at the entrance, a tile pathway on a vertical plane, a mosaic ceramic bench and a low wall made up of broken bricks. The research team did not interfere with the design process in any way but rather recorded and examined the composition of materials, construction processes, sensory experience, spatial relationships of the nodes and then inferred a general reconstruction grammar that can be used to describe the nodes. In order to investigate the relationship between the perception of the material characteristics of wastes and the memory of the place, the physical samples were brought to the potential users, such as long term residents and those who are close by to the place, during the conceptualization stage. Then it was possible to conduct semi-structured interviews to get subjective comments on the recognition of the materials, comfort of the senses, and effects on memory.

5. Analysis of the sensory properties of waste materials and development of a material reconstruction grammar

5.1. Analysis of the sensory properties of waste materials

The research team has been working on the properties of the waste material samples that were taken in the field, at Deji Alley and a property profile was established in three different dimensions: touch, sound and sight.

Tactile Dimension: The blue bricks were tested for surface touch, and 20 samples were taken to measure their thermal conductivity, roughness, and texture. The mean value of the roughness of the surfaces of the blue bricks was much higher than that of the newly produced blue bricks because of the long-term exposure and the remaining mortar. It is possible to sense a small amount of projecting mortar particles on the surface of the brick when it was run by fingers, as well as indentations caused by weathering. This sensation of being both coarse and cozy was reported in the test as similar to the feeling of touching the wall of an old house. The roof tile fragments had sharp edges and moss-covered surfaces which were slightly wet and slippery to the touch. There were also sharp ends of the porcelain pieces, but they were not too hot because they were glazed, which made the contrast of tactile feelings very impressive.

Auditory: When the waste materials are tested in a tapping and stomping test, the whole blue bricks give a dull thud-thud when they come together, and when they hit the red brick pieces, they produce a sound that is much sharper. The sound of the roof tiles crushed by foot pressure sounds like a crackling and it can be heard very well in the alleyways which are old and not so noisy. When rubbed against each other, the porcelain fragments will make a small rustle noise as opposed to the acoustic qualities of the traditional wood-fired porcelain.

Visual Dimensions: The reclaimed materials have mainly bluish-gray, brick red and off-white colors, which constitute a low-saturation warm gray color palette. Surface marks are as follows: mortar residue (irregular white or light grey patches), soot stains (dark brown to black), mossy green spots and weathering cracks. These marks record the history of the use of the building; e.g. the dark brown to black spots with soot show that the brick was formerly situated near a stove or flue.

5.2. Refining the design syntax for sensory reconstruction

This paper has been conducted on the basis of the field survey and analysis of materials of the important nodes in the Deji Alley project that were completed; as a result, four grammars of reconstruction have been discovered with universal applications. The broken bricks are stacked in either a regular or irregular pattern to build volumes and boundaries. In the case of header courses and herringbone patterns, regular stacking is used to create an orderly appearance and tactile rhythm of low walls and the base of feature walls; but in the case of irregular stacking, there is more diversity in texture and relief, which is more suited to natural-style bordering. This was the technique applied in the Deji Alley project where it was used to construct dry-laid low walls using broken bricks, the gaps between the bricks allow the passage of light through them so that they appear to be dappled with light and shadow.

The mosaic art is a way of inserting the shattered ceramic pieces and tiles into the surface of benches or walls in order to create some sort of spots of touch. The ceramic fragments have been glazed and their surfaces are smooth as opposed to the roughness of the cement base, which has blue-and-white patterns randomly distributed on it. Practically, the sharpness of the pieces should be removed by sanding to avoid any chance of scratches.

The vertical laying technique is used to place whole or half tiles vertically and make permeable paving. The arched form of the tiles enables minor elastic distortion when subjected to pressure, creating a wave-like undulation underfoot, and the spaces between tiles allow rainwater to pass through. Therefore, it is particularly suitable for memory trails and small plazas, and even a slight sway and the soft sound of footsteps can be part of a multi-sensory experience.

Lastly, the cage-filling technique involves putting large waste materials like broken bricks and concrete blocks into galvanized steel wire cages to create gabions. The industrial rationality of the wire cages against the warm, ruin-like nature of the infill material makes this technique applicable to entrance signage and retaining walls. Importantly, this process enables the waste material to maintain its original shape without being crushed, hence ensuring that the maximum amount of material traces is preserved.

The four methods are very different in the way they can be applied and used. The stacking technique is a simple one; it can be done quickly, and the boundary and the base can be constructed with ease, though its effectiveness in terms of sensory experience will be determined by how rich the texture of the bricks was. The vertical-laying method is the most labor-intensive, but the tactile contrast (smooth/rough, cold/hot) is the most intense. The vertical-laying method provides the highest auditory and kinesthetic effect, yet the space that is not much walked through has the lowest load-bearing capacity. The wire-cage filling technique is the best to use when there is a need to have good structural integrity as well as to preserve the materials; however, the industrial look of the wire cage may not fit in some of the old areas.

6. Overview of the case study renovation project and site survey

6.1. Site overview and design concept

There is a vacant lot in the shape of a triangle of about 150 square meters within the renewal area of Deji Alley. It was originally a collapsed courtyard, which is surrounded on three sides by ancient blue-brick walls and the ground level is around 0.6 meters below the alleyway. This lot is situated at the center of the neighborhood, where people pass through every day, but it has been left to decay and become littered with construction waste. The location was chosen as a center for renovating public space.

According to the display panels at the site and the public information, the design idea of this project is The Tactile Sense of Memory, which transforms the site from a heap of ruins into a tangible container of memory. The design keeps the historic walls on three sides of the site and uses the on-site construction waste to form four main components: a cage-filled entrance landmark wall, a memory walkway made of vertically laid roof tiles, a tactile bench made of broken ceramic mosaic, and a low wall made of dry-laid broken bricks. The design follows the principles of minimum transportation, keeping the original state, sensation first, and safe strengthening. All materials used are collected on-site without any off-site transportation; the waste materials keep the original shape after simple cleaning and passivation treatment. The construction period was from April to May 2024, and the project duration was about 4 weeks.

6.2. Field survey records

In May 2026 (after project completion), the author conducted systematic on-site observations, surveying, and documentation of the four nodes. See **Table 1**.

Table 1. Field survey records

Node name	Location and dimensions	Materials and construction	Visual impression
Cage-Filling Entrance Signage Wall	On both sides of the site entrance; 2.4 m long, 1.2 m high, and 0.5 m wide on each side	Galvanized steel wire mesh cage (50 × 50 mm mesh size, 3.5 mm wire diameter) filled with large blue bricks and concrete fragments; the front features an arrangement of smoke-stained black-spotted bricks	Sunlight casts shadows through the mesh; when a finger is inserted into the mesh, one can feel the surfaces of different materials, with distinct tactile differences
Vertically Stacked Tile Memory Path	In the center of the site, a 12-meter-long, 1.5-meter-wide curved path	Approximately 850 small blue roof tiles are vertically embedded in a coarse sand base, with 3 cm protruding above the surface; the edges are bordered with red brick fragments	While walking, the soles of the feet sense a 5–8 mm elastic give, accompanied by a faint “rustling” sound
Tactile Bench with Shattered Ceramic Mosaic	Located beneath the old wall on the north side, measuring 4.5 m long, 0.5 m wide, and 0.45 m high	The surface of the plain concrete base is embedded with broken ceramic tiles retaining their blue-and-white patterns; the edges are ground to a dull finish and coated with an epoxy resin sealer	To the touch, smooth ceramic tiles alternate with the rough base, creating rapid changes in perceived temperature
Low dry-laid brick wall	Located along the southern boundary of the site; 8 m long, 0.6 m high	Dry-laid red brick fragments without mortar, filled internally with fine-grained crushed stone, and topped with intact blue bricks	Porosity is approximately 15%, allowing for unobstructed views and air circulation; light filters through the gaps, creating dappled patterns of light and shadow

Research Summary: The four nodes employ four distinct design approaches—cage filling, vertical masonry, mosaic, and stacking—to create differentiated sensory experiences on the tactile, auditory, and visual levels, collectively demonstrating the design potential of local waste materials across multiple sensory dimensions.

6.3. Construction information and structural key points

Based on site inspections and interviews with construction workers (two masons), this study documented the following structural details: Some blue bricks in the wire-mesh-filled walls that exceeded 300 mm in size had to be broken down to less than 200 mm to fit into the wire mesh; a 5-cm-thick cement-stabilized crushed stone base was added beneath the sand layer of the tile walkway to enhance load-bearing capacity; the ceramic fragments in the broken-ceramic benches were embedded to a depth of approximately two-thirds of their thickness (about 3–4 mm), and the surface was coated with a transparent epoxy resin sealer to prevent detachment. These construction details safeguard the structural integrity and longevity of the project.

7. Effect evaluation and discussion

7.1. User feedback and effect evaluation

The author interviewed the local residents and passersby in May 2026 using semi-structured interviews. The total number of people interviewed was 15, with 9 long-term residents (those who had lived in Deji Alley for over 10 years) and 6 nearby users (residents of neighboring areas or business owners) aged between 32 and 78.

Table 2. User feedback and effect evaluation

Evaluation dimensions	Key findings	Typical feedback	Statistical data
Material recognition	The vast majority of respondents were able to accurately identify the source of the materials	Local residents identified the soot-stained bricks as having once belonged to the chimney of the Wang family's old kitchen	14/15 (93%)
Sensory comfort	The springy feel of the walkway received positive reviews, but poses safety risks for the elderly; the benches were generally recognized as cool and comfortable to sit on	Walking on the tile path is springy and enjoyable; older adults need to walk more slowly; the broken-ceramic benches feel cool to the touch and have a smooth surface	Walkway: 11/15 (73%) Benches: 14/15 (93%)
Memory-triggering effect	The memory-triggering effect was significant among original residents, but weaker among non-original residents	The sound of footsteps on the tiles reminds one of eaves; the unevenness of the brickwork brings to mind leaning against old walls; the blue-and-white patterns of the ceramic tiles resonate with memories of water jars	Long-term residents: 8/9 (89%) Non-residents: 3/6 (50%) Total: 12/15 (80%)

In general, the wastes of local origin were found to be more useful in terms of their ability to be identified and to create a memory of the waste materials used by the long-term residents. The sensory comfort was also good on the whole, though there is a need to focus on the safety of the tile walkway that is upright-laid for the elderly.

7.2. Discussion on construction feasibility and durability

Concerning the construction feasibility and durability issues that were brought up in the review, the research team has gathered the following particular data and observations based on the on-site testing and structural analysis:

The pathway was constructed in such a way that it is laid vertically and its compressive strength, as well as slip resistance, are quite high (within the first month of its completion, there were 30-50 people who passed through the site per day), and the research team has tested the friction coefficient of the tiles using a pendulum-type test. The mean value of BPN was 68 in dry state and 55 in wet state, and both values were higher than the minimum value of 45 in the Code for Design of Accessibility, which requires the surface to be non-slippery (GB 50763-2012). Nevertheless, this path can only be used in low-traffic areas within the community but cannot be used as a major street or an emergency exit.

(1) The Broken Ceramic Tile Puzzle Bench Safety

It was not until all the edges of the tiles were ground and then covered with an epoxy resin sealer that there was no sharpness in the surface. The simulated usage test (500 sit-to-stand tests, 75 kg load) revealed that there were no broken or detached tile. But, at the lowest temperature conditions (the historical low temperature in Ningbo is -5°C), the epoxy resin can be brittle; hence, it is advisable to make a routine check on the sealing layer every two years.

(2) Long-term durability assessment

According to aging information on comparable traditional brick-and-tile buildings in the Ningbo region, the physical lifespan of blue bricks when subjected to normal outdoor conditions (except prolonged water immersion) can be over 50 years. Nevertheless, a portion of the blue bricks that will be utilized in this project has already developed weathering cracks and about 15 percent of the bricks have a layer of weathering more than 5 mm thick on their surfaces. In accordance with the applicable provisions on the durability of brick masonry in the Code for Design of Masonry Structures (GB 50003-2011), it is advised to introduce a

routine inspection system once every five years, which should be aimed at checking the extent of powdering in heavily weathered bricks and the rate of fragmentation of tiles, and replacing powdery materials where required.

(3) Compliance discussion

Urban public space construction acceptance is currently based on two main technical specifications, namely the Technical Specifications of Urban Road Maintenance (CJJ 36-2016) and the Specifications of Construction and Acceptance of Landscape Gardening Projects (CJJ 82-2012). Although these standards provide clear quantitative criteria of strength, levelness and durability of paving materials, they were developed with new, industrially produced materials in mind and do not cover reuse of waste materials. In Deji Alley project, structural acceptance requirements were satisfied by a composite design of recycled materials + new base materials (e.g., roof tiles + cement-stabilized crushed stone base, broken ceramics + concrete base), whereas the proportion of recycled material in the surface layer was referred to as an artistic expression instead of a structural layer, thus bypassing some compliance hurdles.

7.3. Discussion on the mechanisms linking the syntax of sensory reconstruction and place memory

Based on the above studies and analyses, this study has further explored the mechanism relating the sensory qualities of waste materials to place memory. The practice of the Deji Alley project proves that it is exactly those imperfect qualities on the surface of waste materials, such as cement paste, soot stain, moss, weathered cracks, etc., that act as the key mediators to awaken residents' place memories. Different from smooth and homogeneous new materials, these traces contain specific information about everyday life: a blue brick stained with soot may recall a family's kitchen fireplace; a moss-covered roof tile may remind one of the eaves of an old house. This association is especially strong in the tactile sense: the friction between finger and rough brick surface, the rocking sensation underfoot when stepping on an elastic tile, the change in temperature between skin and smooth, cool ceramic tile surface; these physical sensations subconsciously trigger residents' tactile memories of scenes from their previous lives.

7.4. Analysis of the mechanisms of sensory reconstruction of waste materials

The Deji Alley project demonstrates that the so-called flaws on the surface of waste materials, such as adhering mortar, soot stains, moss, and weathering cracks, are precisely what trigger place memory. Therefore, a different view of abandonment and value is formed in sensory design; instead of perceiving engineering remnants as defects to be rectified, they are recognized as materials that record the story of a building over time. Old bricks and tiles are not uniform new materials; they carry rich concrete information about life in the past, such as a soot-stained blue brick recalling a family kitchen or a moss-covered tile remembering the eaves of an old house. Thus, the waste that once had to be concealed is now a carrier of memory that can be displayed actively.

Based on the interview data in this study, tactile and auditory feedback, such as rough texture, a springy sensation underfoot and the sound of footsteps, are more strongly associated with personal memory than visual perception alone. This result provides theoretical support for Merleau-Ponty's phenomenology of the body; that is, memory is not generated by abstract ideas but by the direct engagement of the body in life. Waste materials can be felt directly through touch to create a kind of waste-feeling; thus, aesthetic judgment will be bypassed, and at a more fundamental level, people will simply experience "what it feels like".

Therefore, when using waste materials in design, the emphasis should be on the properties of the materials themselves rather than on visual appeal; the purpose is not to build beautiful environments but to create sensory memories.

The Deji Alley project is also a design solution for the idea of functional renewal. Most urban renewal efforts have focused on functional criteria, such as improving drainage efficiency, paving integrity, facility perfection, etc., and have thus created usable but unappealing spaces. Sensory reconstruction makes sensibility an object of design: the elastic flexibility of the tile walkway, the tactile quality of the broken-ceramic benches, and the dappled light filtering through the dry-stacked low walls have no practical use yet can be seen, touched, and thus remembered. Thus, the Design Logic moves from “landscape to be seen” to “environment to be experienced”, thereby creating a link between the material and the spiritual.

7.5. Four design principles for the sensory reconstruction of waste materials

Based on the above analysis, this study proposes four principles for the sensory reconstruction of waste materials:

(1) Principle 1

Priority on Preserving Traces. It is important to maintain the original traces on the surface of the waste (mortar, soot, moss, cracks) as it is not possible to erase or cover them.

(2) Principle 2

Tactile Experience Takes Precedence Over Visual Presentation. Design decisions should prioritize the tactile qualities of materials (rough/smooth, warm/cool, soft/hard) over visual effects.

(3) Principle 3

Low-Tech Adaptation. The four reconstruction methods do not need special equipment and can be used in micro-renovations of older communities with small budgets and limited construction conditions.

(4) Principle 4

Safety and durability should be considered as the primary design specifications. In addition to focusing on sensory experience, sharp edges need to be rounded off, and a periodic inspection system needs to be put in place for severely weathered parts.

8. Conclusion

This study explores the concept of local waste materials in urban renewal through the lens of sensory reconstruction, defined as a material reconstruction process grounded in tactile, auditory, and kinetic experiences. Through post-project research and analysis of the Deji Alley project, the study identifies four replicable design grammars: stacking, collage, vertical masonry, and cage-filling, and examines the tactile mechanism linking the original traces of waste materials to site memory. The three main results are shown in the literature review, field survey and case studies.

First, the original traces left by the reclaimed materials, such as mortar residue, soot stains, moss growth and weathering cracks, are special sensory resources that can effectively trigger the place memories of residents. These imperfect surfaces of new materials are not smooth and uniform; they have accumulated real-life experiences and thus carry tactile memories and emotions. Second, the four reconstruction methods are both feasible and scalable. Requiring no special equipment and executable by masonry workers with wire cages and cement mortar, they are suitable for small-scale renovation projects in older neighborhoods

with limited budgets, such as entrance signs, paving, seating, boundary features, etc. Third, the standards for judging waste-material design should prioritize sensory experience over visual appeal. The study proposes that tactile, seating, and auditory experiences should serve as the main assessment indicators, placing the user's physical engagement at the center of evaluation to promote neighborhood integration, the inheritance of historical memory, and urban intensification.

This study also has some deficiencies: severely weathered bricks may deteriorate in five to ten years and require frequent inspection; current construction standards are geared towards new materials and may not meet compliance requirements for waste-material use. In the future, three-dimensional scanning and robotic mosaic technology can be used to create more complex topological structures from waste materials, and relevant policies will also be improved.

Disclosure statement

The authors declare no conflict of interest.

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