



Stone Powder As A Locally Sourced Material For Sustainable, Age-Friendly Residential Flooring

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ABSTRACT

Flooring is more than a finishing material in a home. It influences how people walk, how comfortable a room feels, how easily the space can be cleaned and how much maintenance it needs. These considerations become particularly important for older adults, as changes in balance, eyesight, walking ability, strength and sensitivity to temperature can affect their everyday movement. At the same time, activities such as cutting, grinding and polishing stone generate fine waste materials. Some of this mineral waste may have value as a secondary raw material instead of being discarded. This paper brings these two concerns together by exploring the possible use of locally available stone powder in a sustainable flooring concept for age-friendly residential interiors.

The study does not assume that a tile containing stone powder will automatically be safe, warm, durable or better for the environment. Its performance would depend on the type of stone, particle size, binder, production method, surface finish, installation and maintenance. Bhopal is considered a possible area for local material investigation, not a confirmed source of supply. The availability, nature and quantity of suitable stone powder would need to be checked through visits and discussions with local stone-related businesses.

Keywords: stone powder; stone waste; sustainable flooring; older adults; age-friendly interiors; Bhopal; circular design; thermal comfort.

1. INTRODUCTION

Flooring is often chosen according to its appearance, price and ease of cleaning. However, it also has a direct effect on how people use and move through a home. For example, someone getting out of bed at night may need to walk towards a cupboard or doorway in limited light, sometimes while using a walking aid. A floor that is glossy, uneven, poorly fitted or visually confusing may create difficulties for some users, even if it looks attractive. For older residents, flooring should therefore be considered in terms of movement, visual clarity, maintenance and everyday comfort, rather than appearance alone.

Research into ageing and the built environment shows that falls are influenced by several factors, including a person's physical condition and the surroundings in which they move. Flooring is one part of this wider environment, but it is difficult to separate its effect from other elements. Lighting,



furniture placement, floor-level changes and clear walking routes also matter. Flooring should therefore be planned as part of the overall room design rather than treated as an isolated surface. (Chuangchai, 2017; Lee et al., 2020)

The environmental impact of building materials is another concern. Construction uses large amounts of natural resources, while quarrying and stone-processing work can produce fine by-products such as stone dust, marble slurry and cutting residue. Researchers have explored the use of these materials in concrete, mortar, ceramic products and other construction applications. However, their suitability depends on factors such as mineral composition, particle size, cleanliness and the way they are processed. (Gazi et al., 2016; Haddad et al., 2023)

This research connects the issue of stone-processing waste with the need for age-friendly residential flooring. It asks whether stone powder available in the local area could become a visible ingredient in a decorative tile concept that does not rely on resin as its main binder. The idea is still at the concept stage; it is not a completed or tested product. Its safety, strength, cost, environmental impact and thermal behaviour would all need to be examined before any firm claims could be made.

2. BACKGROUND AND REASON FOR CHOOSING THE TOPIC

2.1 From sustainable materials to a specific flooring idea

The research began with a broad interest in using materials that are often discarded in interior and building design. Stone powder was selected for closer study because it is mineral-based, may offer different natural shades depending on its source and has already been examined in other construction mixtures. Studies of marble slurry and stone dust show that some stone-processing by-products can be put to use in selected applications rather than being treated only as waste. (Gazi et al., 2016; Solanki et al., 2023)

This led to a more specific design question: could stone waste become an intentional part of a flooring tile, rather than being used only as an unseen filler in another building product? Depending on the manufacturing process, fine stone powder might act as a major mineral ingredient, a filler or a source of colour and texture. The role it can play will depend on the binder and the final mix. A resin-free approach is being considered so that synthetic resin is not the central binding material. However, an alternative binder would also need to be assessed for strength, durability, environmental impact and suitability for indoor use.

2.2 Why focus on older adults?

The next step was to identify a group of users whose everyday needs could guide the design. Older adults may spend a large part of their day at home, and some experience changes in balance, mobility or confidence while walking. Research into older people's perceptions of floor safety suggests that surface texture, joints, colour and the surrounding environment can influence how safe a floor appears. Alcántara and colleagues studied participants over the age of 60 and found that features of the floor surface can affect people's judgement of walking safety. (Alcántara et al., 2008)



Research on balance and impact-absorbing flooring also makes it clear that there is no single flooring solution that is best for every older person. A softer surface may reduce the force of impact during a fall, but it can also influence walking stability, cleaning and the movement of walking aids. A tile containing stone powder would probably behave more like a hard floor, depending on its construction. For this reason, the present study focuses on age-friendly design considerations such as an even surface, secure installation, clear visual patterns and safe transitions. It does not present the proposed tile as a fall-prevention product. (Lachance et al., 2017)

2.3 Why consider underfoot thermal comfort?

The concept also considers a familiar experience: hard mineral floors can feel cold to bare feet in certain conditions. This sensation is influenced by several factors, including the surface temperature, room temperature, thermal properties of the material, tile thickness and the length of time the foot remains in contact with the floor. Research on thermal comfort in Indian homes suggests that the comfort needs of older residents deserve more attention. However, this research does not prove that stone powder can make a floor warmer. The thermal behaviour of the proposed tile would need to be studied separately. (Sudarsanam & Kannamma, 2023)

2.4 Why a local Bhopal focus?

Using materials from nearby sources can make a design project more connected to its location and may reduce transport requirements when the source is genuinely close. Bhopal is therefore proposed as the area in which to look for possible sources of stone powder. These may include stone-cutting and polishing workshops, tile and stone suppliers, or businesses dealing with building materials. At present, no particular business or supply arrangement has been confirmed. A local visit is needed to identify what types of stone waste are generated and whether any of them could be suitable for further study.

It is important to remember that not all stone powder is the same. Waste from marble, granite, sandstone and engineered stone can differ in mineral content, colour, particle size and possible contaminants. The research should identify the actual source and material instead of treating every type of powder as interchangeable. If a dependable source cannot be found within Bhopal, this should be recorded clearly; suppliers from nearby areas could only be considered as an alternative with their location stated.

3. AIM, OBJECTIVES AND RESEARCH QUESTIONS

3.1 Aim

To establish a research-based design direction for investigating locally sourced stone powder as a component in a resin-free flooring tile concept for age-friendly homes, using Bhopal as the proposed area for material sourcing.

3.2 Objectives

- To study published research on stone powder, marble waste and other by-products from stone processing that have been used in construction materials.



- To understand the flooring features that matter to older adults, including surface texture, slip resistance, joints, colour, visual clarity and ease of movement.
- To review research on thermal comfort among older adults and identify what still needs to be understood about the temperature and feel of a floor surface.
- To explain why stone powder is worth investigating and identify the information required to confirm whether suitable material is available in Bhopal.
- To prepare a literature-based research method and a proposed local case-study visit, without presenting uncollected information or untested results as facts.
- To identify the gaps in existing research and set out design considerations for the next stage of the project.

3.3 Research questions

- What does existing research indicate about the reuse of stone powder and marble waste in construction materials?
- What flooring design factors are relevant to older adults' safety perception and everyday use of residential spaces?
- What potential design value could local stone powder offer in terms of material reuse, colour, pattern and place-based sourcing?
- What evidence is needed before a stone-powder tile can be described as safe, durable, easy to maintain or thermally comfortable?
- How can a proposed Bhopal site visit help verify the availability and characteristics of locally generated stone waste?

4. LITERATURE REVIEW

4.1 Stone waste as a secondary construction resource

Gazi, Skevis and Founti (2016) examined fine waste produced by quarrying and the ornamental stone industry. Their review explains that stone dust and marble sludge can create challenges for waste management, but may also have uses in construction. The authors note that results depend on the type of by-product and the application in which it is used. They also identify the need for further research into processing and long-term performance. This supports the idea of exploring stone waste as a resource, while making it clear that each material must be assessed on its own properties. (Gazi et al., 2016)

Haddad and colleagues (2023) reviewed studies in which stone dust was used as a partial replacement for natural sand in concrete. They discussed its effect on workability, strength, durability and environmental performance. Concrete is not the same as a thin flooring tile, but the review is still useful because it shows how particle characteristics and mix proportions can influence the final product. For the proposed tile, the amount of stone powder and the expected strength should not be decided without a defined formulation and supporting evidence. (Haddad et al., 2023)



Solanki and colleagues (2023) studied the development of ceramic tiles containing a high proportion of marble slurry. Their work considered marble waste alongside conventional ceramic ingredients and used modelling and analysis to examine the mixture. This research is particularly relevant because it shows that mineral waste can be considered in the production of flooring materials. However, ceramic tiles are manufactured through a firing process, whereas the present concept considers a resin-free composite. The study therefore provides background support for the idea, not proof that the proposed tile will have the same properties. (Solanki et al., 2023)

A 2023 review on waste marble powder in cement-based composites examined its influence on fresh mixtures, strength, durability and microstructure. The review shows that marble powder has been considered as a replacement or supplementary ingredient in different cement-based materials. One important point for this project is that the term 'stone powder' is not specific enough for material selection. The type of mineral, fineness, cleanliness and compatibility with the binder should be known before the material is included in a tile specification. (Exploring the potential of waste marble powder, 2023)

4.2 Flooring and older adults' safety

Alcántara and colleagues explored how floor design affects older adults' perceptions of walking safety. Their study considered features such as texture, joints, colour, surface profile and the overall surroundings. The findings suggest that texture and the visual character of a floor can influence how safe people believe it to be. For the proposed tile, this points towards a carefully selected surface finish and controlled patterns rather than a highly polished surface chosen only for appearance. These findings do not replace proper testing of friction or slip resistance. (Alcántara et al., 2008)

Redfern, Moore and Yarsky (1997) studied standing balance among younger and older participants on different flooring surfaces and under different visual conditions. Their work is an early example of research connecting floor conditions with balance. It reinforces the idea that flooring is part of the physical environment in which a person moves. In a home, this means paying attention to uneven edges, loose flooring, unexpected changes in level and transitions that are difficult to see. (Redfern et al., 1997)

Lachance and colleagues (2017) reviewed compliant flooring designed to reduce injuries associated with falls among older adults. They found that softer flooring can reduce impact forces, although its effect on actual fall outcomes, cost and workplace safety is more complicated. This is an important reminder that a floor should not be considered safe simply because it is hard, strong or made from a natural material. The proposed stone-waste tile should be treated as a sustainable material idea that must be assessed against age-friendly design requirements, not as a product proven to prevent injuries. (Lachance et al., 2017)

Kim and Lockhart (2020) examined how older adults move when changing from carpet to vinyl flooring. Their study draws attention to the way floor transitions can affect walking. In residential spaces, changes in material at a bedroom doorway or between adjoining rooms should therefore

be planned carefully and kept as level as possible. If the proposed tile is made in separate replaceable units, the joints and edges must also be designed so that they do not become trip hazards. (Kim & Lockhart, 2020)

4.3 Thermal comfort and ageing

Sudarsanam and Kannamma (2023) investigated summer thermal comfort in the homes of older people in India. They collected questionnaire responses alongside measurements of indoor environmental conditions. Their research highlights that older residents have specific thermal comfort needs and that more studies are needed in Indian residential settings. It supports the wider focus on age-friendly housing, but it does not show that stone powder changes floor temperature or makes a tile feel warmer. (Sudarsanam & Kannamma, 2023)

Tang and colleagues (2022) reviewed approaches for assessing thermal comfort among older people living in care homes. These included heat-balance models, adaptive comfort methods and thermographic techniques. Their work shows that thermal comfort can be difficult to measure and that each method has limitations. For this study, the key point is that any future claim about floor comfort should be based on a clearly explained method. Room air temperature should also be distinguished from the temperature of the floor and the way a person experiences it. (Tang et al., 2022)

4.4 Sustainability, circular design and local sourcing

Circular design encourages materials to remain useful for as long as possible and looks for ways to put by-products back into productive use. In construction, this may involve replacing some newly extracted material with a suitable secondary resource. Stone powder could be considered for this purpose because it is produced during physical stone processing. However, the presence of recycled material alone does not prove that a product has a lower environmental impact. Drying, screening, transport, binder production, manufacturing energy, product life and end-of-life disposal all need to be considered. (Gazi et al., 2016; Haddad et al., 2023)

Sourcing material locally may support a design that responds to its surroundings and could reduce transport distances if a suitable source is nearby. However, the phrase 'locally sourced from Bhopal' should only be used after the source has been identified and checked. During the proposed visit, the research should record the type of business, kind of waste, how often it is generated, what currently happens to it, whether a sample can be obtained and whether there are issues with moisture, contamination or storage. Until this information is collected, local sourcing should be described as an intention for further investigation.

5. RESEARCH GAP

The literature reviewed in this paper shows that stone powder and marble waste have already been studied in materials such as concrete, mortar and ceramic tiles. Other studies have examined how flooring design relates to older adults' movement and perceptions of safety, while separate research has considered thermal comfort in older people's homes. These studies provide a useful starting point, but they do not fully answer the particular design question explored here.



5.1 Identified gaps

- **Material and user gap:** Much of the research on stone waste focuses on construction performance, while studies involving older adults tend to examine movement, safety perception or the built environment. The sources reviewed here offer limited direct evidence that brings locally sourced stone powder together with age-friendly residential flooring design.
- **Product gap:** Findings from studies on marble slurry in fired ceramic tiles or stone dust in concrete cannot be directly applied to a resin-free composite tile. The proposed product's mix, binder compatibility, strength, resistance to wear and water behaviour are still unknown.
- **Local context gap:** The available literature does not confirm which types of stone powder are regularly generated in Bhopal or whether they are clean and suitable for reuse. Local investigation is therefore needed before making claims about supply or environmental benefits.
- **Thermal comfort gap:** Existing studies discuss thermal comfort in homes occupied by older adults, but they do not demonstrate that a tile made with stone waste can reduce the feeling of cold underfoot. Both the material's thermal properties and users' responses would need to be studied.
- **Design and safety gap:** Colour and pattern can give a floor visual character and may help organise a space, but decoration alone does not make a floor safe. Slip resistance, glare, joint design, level changes and visual contrast all need separate consideration.
- **Life-cycle gap:** Recycled content by itself is not enough to establish that a product is sustainable. The binder, processing requirements, energy use, transport, expected service life, maintenance and disposal options should also be taken into account.

5.2 How the proposed thesis emerges from the gap

The thesis direction develops by bringing these research areas together, rather than suggesting that stone waste or flooring safety has never been studied before. Existing studies show that stone by-products can be used in some building materials and that flooring conditions matter to older adults' movement and sense of safety. The opportunity is to examine both themes through one design-led project: a resin-free tile concept using stone powder from a verified local source, with its appearance and function guided by age-friendly residential requirements. The originality of the work lies in this particular combination and local investigation, not in claiming a world-first invention.

6. MATERIAL RATIONALE: WHY STONE POWDER?

6.1 Availability as a by-product

Stone powder can be produced during stone cutting, sawing, grinding and polishing. Instead of viewing all of it as material for disposal, this project considers whether a suitable portion could be used as a mineral ingredient in a flooring tile. The first task is to identify exactly where the powder comes from. Different stones can produce powder with different colours, particle sizes, hardness, mineral composition and contaminants. For that reason, the early stages should use a clearly identified source and avoid mixing unknown materials. (Gazi et al., 2016; Haddad et al., 2023)



6.2 Potential for colour and pattern

Depending on the stone and the binder, the powder may add natural colour or texture to the finished surface. It may be possible to explore different shades or a speckled, terrazzo-like appearance through controlled particle distribution. Simple borders or tonal areas could also help organise the look of a bedroom. However, colour should remain consistent between production batches; otherwise, replacing a damaged tile may be difficult. Patterns should be calm and clear, and should not create the impression of holes, steps or sudden changes in floor level. (Alcántara et al., 2008)

6.3 Why a resin-free direction?

The term 'resin-free' describes the direction being explored: the project is looking for a binder other than a conventional resin-based system. This does not automatically mean that the tile would be safer or more environmentally friendly. Cement-based, mineral or other binders also have environmental impacts and must meet requirements for curing, strength, durability and repair. The final choice should depend on how well the binder works with the selected powder, the intended indoor use and the available manufacturing process. The term should only be retained if the final formulation contains no resin binder.

6.4 Adaptability for residential interiors

The material could be developed as small modular tiles or as larger panels, depending on the production method. Smaller units may make it easier to replace a damaged section, but this would depend on the installation system, joint detail and consistency of colour and size. The design could be adjusted for different bedroom interiors through natural mineral shades, muted colours and simple geometric patterns. At this stage, these are possible design directions rather than proven advantages.

6.5 Limits of the material idea

Using stone powder does not automatically produce a tile that is strong, slip-resistant, warm, waterproof or inexpensive. A high proportion of fine powder may change the amount of binder required and affect porosity, shrinkage or the final surface. Fine dust also needs to be handled carefully because inhaling it can be harmful. Any practical development stage would therefore require a traceable material source, suitable dust-control measures, safe handling procedures and relevant tests. This paper is based on literature and does not report a finished prototype or test results.

7. PROPOSED CASE STUDY: BHOPAL LOCAL MATERIAL CONTEXT

7.1 Purpose of the case study

The proposed Bhopal case study is intended to find out whether suitable stone powder is available locally and to understand the practical issues involved in reusing it. The visit has not yet been presented as completed, and no supplier has been confirmed. The purpose is to move beyond a general material idea by observing possible stone-processing and building-material businesses, subject to permission and access.

7.2 Proposed study locations and participants



Possible places to approach include stone-cutting and polishing workshops, tile and stone shops, building-material yards, small fabrication units and waste collection points in and around Bhopal. These are suggested categories for investigation, not confirmed sources. The student should first check whether a location actually handles stone and whether staff can identify the origin of the powder or slurry. People who may be able to provide useful information include business owners, workers, suppliers, waste handlers and interior designers. If the institution approves, older residents or caregivers may also be consulted about flooring preferences.

7.3 Information to record during a site visit

- Type of stone handled, such as marble, granite, sandstone or another identified mineral.
- Form of waste: dry powder, wet slurry, chips, sludge or mixed debris.
- Approximate frequency of generation and whether the waste is seasonal or irregular.
- Current handling: reuse, sale, storage, collection or disposal, as reported by the source.
- Visible contamination, moisture, mixed materials and storage conditions.
- Whether a small representative sample can be obtained with permission.
- Transport distance and practical access to the source.
- Potential occupational health precautions for handling fine dust.
- Photographs of the site only with permission and without exposing private information.

7.4 Case-study analysis

Information from each location should be organised into a short source profile. This can include the type of stone, reliability of supply, visible contamination, storage conditions, processing requirements and whether the material appears suitable for further investigation. A source should not be described as sustainable or appropriate simply because it is nearby. Its quality and consistency are just as important as distance. If the visit does not identify a suitable local source, that outcome should also be reported honestly.

7.5 Locality and adaptability

If a regular and suitable source is identified, the tile concept could become more closely connected to the local context because its material and appearance would reflect a regional waste stream. The natural shades of the powder may help guide a local colour palette. On the other hand, changes in the source material could make colour matching and consistent production difficult. Adaptability therefore involves both design flexibility and an understanding of the limits of local material supply.

8. RESEARCH METHODOLOGY

8.1 Research design

This paper follows a qualitative approach based mainly on published literature, alongside a proposed exploratory case study in Bhopal. It reviews existing research and uses that information to develop a design rationale. No laboratory experiments, completed surveys or measured product-performance results are included. This approach is suitable for defining the thesis direction, identifying relevant design criteria and explaining what should be investigated in a later stage.



8.2 Literature search strategy

Relevant publications were identified through searches using Google Scholar-related terms and journal or publisher websites. Search phrases included ‘marble slurry sustainable tiles’, ‘stone dust construction materials review’, ‘older adults flooring safety perception’, ‘flooring and balance older adults’, ‘thermal comfort elderly Indian residences’ and ‘age-friendly residential design flooring’. Preference was given to peer-reviewed articles, review papers and sources with a DOI or a stable publisher page. The selected material was relevant to at least one of the main themes: stone waste, flooring, ageing or thermal comfort. This is a focused narrative review, not a formal systematic review, and it does not claim to cover every publication on the subject.

8.3 Inclusion and exclusion criteria

Sources were considered relevant if they addressed one or more of the following topics: the reuse of stone or marble waste in building materials; the relationship between flooring and older adults' movement or safety perception; thermal comfort in homes occupied by older people; or design approaches for safer interiors. Research on unrelated waste materials was not central unless it had a clear connection to mineral materials or flooring. Findings from studies on concrete and ceramic tiles are used as background information, not as direct proof that the proposed composite tile will perform in the same way.

8.4 Proposed fieldwork method

A later visit to selected locations in Bhopal could involve observing the work carried out and having short, semi-structured discussions with stone processors or suppliers. An observation sheet could be used to record the material type, physical form, storage method, current handling and possibility of obtaining a sample. If older adults are included in a future interview or survey, they should be told the purpose of the study and participation should remain voluntary. Personal details should not be collected unless they are necessary and the participant has agreed. Any ethics requirements set by the institution must also be followed.

8.5 Analysis method

The literature is organised and compared under four themes: reuse of stone materials, flooring needs of older adults, thermal comfort and local sourcing. If the proposed Bhopal visits take place, their observations can be reviewed under the same headings. The analysis should focus on common findings, differences between sources and questions that still need answers, rather than creating numerical results where no data has been collected. Any quotations from participants should be anonymised and included only with their permission.

8.6 Methodological limitations

The present study has some clear limitations. It relies on published research, and the proposed local field visit and material testing have not yet taken place. The studies reviewed use different materials, methods and groups of participants, so their findings cannot be treated as if they came from one experiment. The availability of suitable stone powder in Bhopal is also unconfirmed.



Finally, a literature review alone cannot establish thermal comfort, slip resistance or long-term durability.

9. DESIGN CRITERIA FOR THE PROPOSED TILE

9.1 Safety and movement

The proposed design should begin with a stable and even floor surface, secure installation and edges that do not create trip risks. Slip resistance needs to be checked using a suitable test for the intended setting; a matte appearance by itself does not prove that a floor is non-slip. Joints should be consistent, narrow and level with the tile surface wherever possible. The flooring should also meet adjoining materials without creating a sudden change in height. (Alcántara et al., 2008; Kim & Lockhart, 2020)

9.2 Visual clarity

Patterns and colours should make the room easier to understand, not harder to read. A calm finish with limited glare and a clear visual difference between the floor, walls and furniture may help people recognise the layout of the space. Decorative borders should not look like steps, holes or obstacles. Highly polished finishes should be avoided where reflected light could make the surface confusing. These are design considerations that should be discussed with users; they cannot be assumed to suit every older person. (Alcántara et al., 2008)

9.3 Thermal and tactile comfort

The concept recognises that some people may experience hard flooring as cold underfoot in certain conditions. However, the surface temperature and thermal behaviour of the proposed material have not been established. If thermal comfort becomes a major part of the thesis, a later study would need to compare the tile with a conventional floor under controlled room conditions and separately collect feedback from users. This paper does not claim that stone powder will make the floor warmer.

9.4 Maintenance and repair

For everyday residential use, a flooring tile should be simple to clean and should withstand ordinary staining and surface wear. If the concept uses individual replaceable units, the design should explain how spare tiles will be stored, how close a replacement colour can be matched and how the joints will remain level. The binder and surface coating should also be reviewed for indoor air quality and compatibility with common cleaning products. These are qualities that still need investigation, not benefits that have already been demonstrated.

9.5 Sustainability and material transparency

Any claim of sustainability should be supported by clear information about where the waste came from, how much is used, which binder is added, how the material is processed and transported, and how long the finished tile is expected to last. The end-of-life stage also matters: a damaged tile may be difficult to recycle if the mineral powder is combined with a binder that cannot be separated. Choosing a resin-free approach may affect this issue, but the complete material system still needs to be assessed. (Gazi et al., 2016; Haddad et al., 2023)

10. DISCUSSION: FROM RESEARCH TO THESIS CONCEPT

The literature points towards a possible direction for the thesis. Research has already considered stone-processing waste as a secondary resource in different construction products. Studies involving older adults show that flooring needs to be considered in relation to walking, surface qualities, visual perception and transitions between materials. Research also recognises thermal comfort as part of residential wellbeing, but general findings about indoor comfort cannot be used to claim that a new tile will feel warmer. Finally, a local investigation is needed to establish whether suitable stone powder can actually be obtained in Bhopal.

Together, these findings suggest a design concept for a resin-free composite tile made with stone powder from a documented local source. Its development would be guided by age-friendly flooring considerations for residential bedrooms. Natural shades, restrained patterns and a modular format could be explored. The design may be adapted to different interiors through changes in dimensions, colour and pattern, while the mineral ingredient would reflect the properties of the selected source. However, flexibility in design does not mean that every type of stone powder will be suitable; the material must first be identified and assessed.

The concept should not be described as a finished flooring solution until its performance has been established. The value of the thesis can come from clearly explaining the design problem, reviewing relevant evidence, identifying a possible local material resource and setting out the checks needed before development. Its contribution lies in connecting sustainable material exploration with the residential needs of older adults, rather than making unsupported claims that the proposed tile is better than existing flooring.

10.1 Comparison with conventional flooring

Ceramic and vitrified tiles are common choices because they are widely available, relatively easy to clean and sold in many finishes. However, some polished options may be slippery and can feel cold in certain conditions. Natural stone offers a distinctive appearance and can be durable, although its price and maintenance requirements vary. Cement-based and terrazzo flooring can support decorative designs and may include aggregates. Vinyl may feel softer underfoot, but its material composition and environmental impact differ between products. The proposed stone-waste tile could provide a way to reuse a mineral by-product and develop a visual identity connected to local materials. At present, however, there is not enough evidence to rank it above conventional flooring in safety, durability, cost, thermal comfort or maintenance.

10.2 Expected design contribution

The expected contribution of this work is a set of design criteria based on existing evidence and a material concept that can guide the next stage of the thesis. It brings together the reasons for selecting stone powder, a plan for investigating local sources, age-friendly flooring considerations and the performance questions that still need to be answered. It does not claim that a prototype has been tested, a survey has been completed, a specific quantity of waste has been reused or environmental savings have been measured.



11. LIMITATIONS AND FUTURE SCOPE

There are several limitations to this paper. The proposed Bhopal case study has not yet been completed, so no local supplier, quantity of waste or regular source of material has been confirmed. No sample has been characterised and no tile prototype has been tested. In addition, the reviewed publications examine different materials and settings, which makes direct comparison difficult. A literature-based study also cannot establish the slip resistance, thermal comfort or long-term durability of the proposed tile.

The next stage could begin with a visit, with permission, to stone-processing workshops or building-material businesses in Bhopal. The student could record the source and type of powder, how it is stored and handled, and whether it is currently reused or discarded. Once a suitable source has been identified, a later design stage could consider a compatible binder, prepare a clearly labelled concept sample and seek technical advice about appropriate tests. If testing is outside the scope of the current thesis, these steps should be presented as future work rather than as activities already completed.

Further study could examine whether the material remains consistent between batches and how it performs in compression, bending, abrasion and water absorption. Other important areas include slip resistance, cleaning, indoor emissions and the temperature of the finished surface. A separate user-focused study could ask older adults how they respond to different colours, textures and patterns. An environmental comparison with conventional flooring would also need a clearly defined scope and reliable data. Together, these steps would provide a stronger basis for judging the product's performance and sustainability.

12. CONCLUSION

This paper has developed a research-based reason for exploring stone powder as an ingredient in a resin-free flooring tile concept for age-friendly homes. Existing studies show that marble waste and stone dust have been investigated for use in construction materials. Research involving older adults also indicates that texture, joints, changes in floor level and visual appearance can influence how people experience flooring and judge its safety. Studies of thermal comfort highlight the importance of considering older residents' needs, but they do not establish that stone powder will reduce the feeling of cold underfoot.

Focusing on Bhopal gives the project a local direction, although a site visit is still needed before the material can accurately be described as locally sourced. The proposed tile could create an opportunity to reuse stone-processing waste and explore natural colours and patterns connected with the available material. Whether this is practical will depend on the source, binder, manufacturing process and performance of the finished tile.

The key research gap identified in this paper is the limited direct connection between locally sourced stone powder, a resin-free composite flooring concept and age-friendly residential design in the literature reviewed. The thesis can address this area by developing a carefully defined concept, setting out design criteria supported by existing research and proposing realistic steps for



future verification. This paper therefore provides a foundation for further design work while avoiding claims that have not yet been supported by testing or field evidence.

REFERENCES

- Alcántara, E., Zamora, T., Poveda, R., Barberà, R., Matey, F., Gimeno, M. C., Sánchez-Lacuesta, J. J., & Prat, J. (2008). Influence of pavement design parameters in safety perception in the elderly. *International Journal of Industrial Ergonomics*, 38(11–12), 992–998. <https://doi.org/10.1016/j.ergon.2008.03.007>
- Chuangchai, W. (2017). A review article: Environmental hazards at home and ergonomics as fall prevention for elderly population. *Journal of Architectural/Planning Research and Studies*, 14(1). <https://doi.org/10.56261/jars.v14i1.104438>
- Gazi, A., Skevis, G., & Founti, M. A. (2016). A review on the utilisation of quarry and ornamental stone industry fine by-products in the construction sector. *Construction and Building Materials*, 102, 769–781. <https://doi.org/10.1016/j.conbuildmat.2015.10.204>
- Haddad, A. N., et al. (2023). A comprehensive review of stone dust in concrete: Mechanical behavior, durability, and environmental performance. *Buildings*, 13(7), 1856. <https://doi.org/10.3390/buildings13071856>
- Kim, H. N., & Lockhart, T. E. (2020). Fall risk in older adults transitioning between different flooring materials. *Sci*, 2(2), 25. <https://doi.org/10.3390/sci2020025>
- Lachance, C. C., Jurkowski, M. P., Dymarz, A., Robinovitch, S. N., Feldman, F., Laing, A. C., & Mackey, D. C. (2017). Compliant flooring to prevent fall-related injuries in older adults: A scoping review of biomechanical efficacy, clinical effectiveness, cost-effectiveness, and workplace safety. *PLOS ONE*, 12(2), e0171652. <https://doi.org/10.1371/journal.pone.0171652>
- Lee, S., et al. (2020). Falls in older adults: A systematic review of literature on interior-scale elements of the built environment. *Journal of Aging and Environment*, 34(4), 351–374. <https://doi.org/10.1080/02763893.2019.1683672>
- Luhar, S., & Luhar, I. (2026). Sustainable recycling and reuse of marble waste in the construction industry: A systematic review towards a circular economy. *Journal of Composites Science*, 10(5), 221. <https://doi.org/10.3390/jcs10050221>
- Redfern, M. S., Moore, P. L., & Yarsky, C. M. (1997). The influence of flooring on standing balance among older persons. *Human Factors*, 39(3). <https://doi.org/10.1518/001872097778827043>
- Sittichoke, C., Buasord, J., Boripuntakul, S., & Sungkarat, S. (2019). Effects of compliant flooring on dynamic balance and gait characteristics of community-dwelling older persons. *The Journal of Nutrition, Health & Aging*, 23(7), 665–668. <https://doi.org/10.1007/s12603-019-1211-0>



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- Solanki, S., Kumar, R., Yadav, A. P., & Gupta, S. (2023). Mathematical modelling and ANOVA analysis to develop sustainable ceramic tiles using high volume marble slurry. *Materials Today: Proceedings*. <https://doi.org/10.1016/j.matpr.2022.12.229>
- Sudarsanam, N., & Kannamma, D. (2023). Investigation of summertime thermal comfort at the residences of elderly people in the warm and humid climate of India. *Energy and Buildings*, 291, 113151. <https://doi.org/10.1016/j.enbuild.2023.113151>
- Tang, Y., et al. (2022). Thermal comfort modelling of older people living in care homes: An evaluation of heat balance, adaptive comfort, and thermographic methods. *Building and Environment*, 207, 108550. <https://doi.org/10.1016/j.buildenv.2021.108550>
- Exploring the potential of waste marble powder as a sustainable substitute to cement in cement-based composites: A review. (2023). *Construction and Building Materials*, 401, 132887. <https://doi.org/10.1016/j.conbuildmat.2023.132887>