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Ideal Storage Conditions for Museum Textiles

Simmi Bhagat[1] and Kanika Sachdeva[2]*

[1]Department of Fabric and Apparel Sciences, Lady Irwin College, University of Delhi, Delhi, India
[2]Conservation Scientist, London, UK

Abstract

Museums around the world are custodians of natural and cultural heritage. It is a well-known fact that most museum collections spend the majority of their lifespan in storage. All these objects in storage require organized facilities that provide stabilized conditions and easy accessibility to the objects. Storage of textile artifacts is a well-laid scientific process where all environmental factors, like humidity, temperature, light, etc., need to be suitable for every artifact. Apart from the environmental conditions, storage architecture and design are other important factors that can affect the safety of the objects. There are enough examples of loss of precious artifacts because of negligent and badly designed storage. Different textile artifacts, depending on their condition, design and composition, need specific storage materials and methods. There cannot be a standard material and a technique attending to the requirements of diverse artifact range. This chapter provides details of three basic things that are imperative to efficient textile collections storage—environment control, storage architecture and design, and storage materials and methods. While the chapter will provide basic essentials for collection storage, best practices need to be object and place specific.

Keywords: Museum storage, storage environmental conditions, museum storage architecture, museum storage design, museum textiles storage

7.1 Introduction

Museums are repositories of objects of cultural, religious, scientific and historical importance. They preserve, research and present collections to the public in the most safe and accessible manner for the purpose of education and enjoyment. It has been reported that most textile artifacts spend most of their lifetime in storage and are ideally taken out for display only once in 5 years [1]. According to ICCROM (RE-ORG), 95% of the museum objects are kept in storage [2]. Many studies have shown that poor storage facilities will put valuable objects at risk. The findings of an international survey conducted by ICCROM and UNESCO in 2011 identified that 25% museums find it difficult to circulate in storage,

**Corresponding author*: Dr.Kanikabhatiasachdeva@Gmail.Com

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about 33% museums are unclear about who is responsible for storage and 50% museums have insufficient storage units. They developed RE-ORG, a method to reorganize storage in museums. This method helps in identifying the problems in all aspects related to storage, such as building and space, furniture and small equipment, management and collection. It has been successfully used across 23 countries.

The importance of collection storage has become an important focus for the museum community across the world. During the 34th ICOM General Assembly held in September 2019, a resolution was adopted on "Measures to safeguard and enhance collections in storage throughout the world" [3]. There is a need for appropriately designed, organized, and maintained storage facilities to stabilize and maintain the condition of objects.

Textiles are organic in nature and are prone to physical and chemical degradation due to many factors. The fundamentals of environment control in museum storage needs to be maintained as advised by experts. Ideal storage areas should have temperature and humidity levels that fall within the recommended range to prevent any physical and chemical alterations. Storage location should be thoughtfully planned according to the museum size and funding. Individual textile items and space availability will influence choices. Housekeeping and trained professionals are essential elements of storage maintenance.

Storage furniture and their materials need special attention. In the Indian context, the storage of textile artifacts becomes much more complex. This is primarily because of the fact that Indian textile artifacts could be made of multiple materials, with each having different characteristics. A typical 16th century skirt or bodice could be made of silk, with a muslin/cotton lining, gold/silver wire embroidery and at some places encrusted with stones, etc. When selecting storage units, it is important to choose materials that will not adversely affect any part of the textiles. A variety of materials, such as acid free cardboard, wood, or metal, are used for storage containers and devices. These should not be placed in direct contact with the textiles. Recommended materials for storage include baked enamel metal shelving units and acid-free lignin-free boxes. For storing textile artifacts, literature describes horizontal orientations that include flat, rolled, folded or mounted storage while vertical orientations include hanging storage.

7.2 Published Standards in Museum Storage

In 1998, Museum and Galleries Commission, U.K., published "Standards in the Museum Care of Costume and Textile Collection" [4]. The document extensively enlists various factors that can ensure a fool-proof storage arrangement for textile artifacts. However, museum collections have become more varied over the period of time. Also, technology has further enhanced the possibilities of making storage facilities more efficient than ever. To be able to systematically discuss various aspects of museum storage, the discussion can be divided into various sections like building architecture, environmental conditions inside storage area, storage design, safety systems, disaster handling & management of dust/dirt & pollution.

7.3 Storage Design and Architecture

Location & design of the building is one of the most important & least discussed factors in museum storage. The importance of a good storage facility has been rightly summed up by this observation, "Inadequate storage buildings in the short run are expensive buildings in the long end" [5]. It is important to note here that most museums are housed in heritage buildings not originally meant to store & display museum collections. However, there are enough examples of modern museum buildings that are planned and designed keeping in mind all requirements of education, storage & display.

There is not much documented literature available on norms for space allocation & architectural design of a museum building. What should be the space allocation and design of a model museum building? This question might not have a single correct answer! However, it is important that this is done keeping in mind the risk potential for the collections. Since most museums' housing textile artifacts might not be solely textiles museums, the storage space has to be allocated and designed taking into consideration utilities for different categories. For example, a National Museum would house collections ranging from sculptures, coin collections, arms & armours, paintings & textiles. While sculptures could be considered a very stable category that does not require much attention in terms of temperature & humidity control; textiles & metallic collections have very different & specific environmental requirements. Keeping this in mind, a museum of national scale would have multiple storage facilities, each catering to the requirements of a specific collection. However, there could be smaller local museums and private collections that cannot afford segregated storage for each artifact category. These museums would then resort to standard norms that could take care of majority but not all the requirements of each artifact. Although some museums resort to localized storage for each section, most museums have dedicated spaces for storage and exhibitions respectively. A document from Philadelphia Museum of Art [6] lays down specific guidelines for a museum storage:

- A storage area dedicated only to storage
- Storage units that would allow curators to view the collection easily, yet would close fully to protect the objects
- Controlled access (security) to the storage area
- Safe and easy object retrieval (without actually handling the object)
- The ability to view objects without removing them from their housing whenever possible
- Environmentally stable conditions (45% relative humidity, 70°F ± 2°)
- A gaseous fire suppression system, backed up by a wet pipe suppression system
- A system for objects to be grouped by:
  - Classification (costume/textile)
  - Country of origin (western/non-western)
  - Type (printed fabric, hat, sampler, etc.)

It is imperative that storage space & design is planned providing adequate protection against environmental changes, pollutants, pests, dirt etc. Another important consideration

for storage buildings is a disaster management system and proximity to exhibition and conservation/restoration spaces. Additionally, it is important to enforce regular upkeep and monitoring procedures to ensure safety of the stored collections. Following sections would further elaborate upon the specific housing requirements of museum textiles and different solutions available to keep deterioration arrested for long durations of time.

7.3.1 Museum Storage Building and Space Allocation

Although there is some literature available about the ideal location of museum storage, not much data is available to map the actual storage location with proposed standards. While museums readily share information about the conservation and museology procedures followed, there are not many pointers about the storage locations in these museums. This could be primarily due to security reasons as museums are storehouses for priceless and timeless pieces of art & culture that need to be secured against unholy intentions.

Most available resources propose ideal museum storage chambers to be sufficiently chaperoned from all exterior influences of temperature, humidity, light, pollution etc. In addition to climatic buffering, these storage chambers need to be in close proximity to exhibition and conservation sites within the museums while restricting access to the few authorized personnel. As discussed earlier, not all museum buildings are ideal constructions. Many of these could be remodelled heritage buildings or buildings built with local limitations of geometry, access and more.

It is advisable for new museum buildings to be constructed in a way that they provide a stable environment to the artifacts. It should be noted here that frequent fluctuations in environmental conditions like temperature, humidity, etc. can be the biggest triggers for the process of degeneration. Artifacts housed in less-than-ideal conditions can be expected to live longer than compared to artifacts that are housed within ideal range but frequently fluctuating environmental conditions. The artifacts tend to reach a state of equilibrium with their immediate environment and frequent changes to these immediate environments could trigger the dormant process of degeneration. Therefore, it is imminent for museum buildings to effectively protect its chambers from external environment changes. It is primarily for this reason that most museums allocate basement spaces as storage areas. The basement spaces have the tactical advantage of being least impacted by outdoor temperature variations. Additionally, they can be safer in terms of limited access options. It is advisable to design storage chambers with high efficiency low-energy designs to make them more environment friendly.

However, in most scenarios, an ageing refurbished building is used mostly because of its historic and cultural value. A thorough assessment needs to be carried out of the building structure, electric wirings, plumbing network etc. before the building is deemed fit for housing delicate historic collections. All parameters of the building works should be adequately assessed and stabilized before huge funds are invested in setting up a museum.

7.3.2 Building Monitoring and Maintenance

Storage chambers/buildings need to be constantly monitored for any fluctuations in environmental conditions. As per the standards published by Museums & Galleries commission, UK (1998), [4] a new building should be intensively monitored both indoors & outdoors

before housing the collection for the first time. The data procured can provide useful indicators about the suitability of the building. Additionally, these data can help in dividing the building into different zones that could be suitable for different purposes according to their natural environmental stability. These zones can be identified naturally or created artificially by air conditioning systems. In either circumstance, the devices used for environmental stability should be supporting the natural environment & not replacing the natural environment of the building.

Once the artifacts have been stored in the building, routine environmental monitoring should be done covering all four seasons. In olden times, it was customary to install thermometers or thermo-hygrograph for continuous monitoring of the storage chambers. With technological advancements, many museum storages are being monitored by computer-operated devices that collect data through intelligent sensors. It is important here to note that not just the environmental factors but human access inside storage chambers also needs to be monitored. As specified by some standards, every person entering the storage chamber can release approximately the same heat as a 60-Watt light bulb and humidity equivalent to a wine-glass full of water per hour.

Museum organizations take various measures to insulate buildings from exterior fluctuations of temperature & humidity. This should include measures like draught-proofing, thermal insulation etc. The buildings need to be sufficiently water-tight while addressing all possible sources of dampness like leaking pipes or water tanks, faulty guttering and missing roof tiles. It is advisable to take technical advice from building specialists so that harmful impacts of these measures like reduced air supply can be taken care of.

7.4 Environmental Conditions

The published handbooks on museum maintenance prescribe temperature levels at 21°C and humidity levels at 50% to 55% RH. However, it also talks of later recommendations of US engineers' Handbook that provides flexibility to temperature, between 16°C and 21°C. Most storage chambers in established museums are centrally air-conditioned with inbuilt climate control. In India, the storage chambers of the National Museum, New Delhi, are also centrally temperature controlled. However, many smaller museums do not have such facilities. These museums then depend on primitive measures like use of silica gel and placement of Thermo hydrographs in storage chambers to keep check on humidity.

7.4.1 Temperature and Relative Humidity

Standard and stable relative humidity (RH) is imperative for maintaining longevity of aged artifacts. High humidity levels can trigger fungal growth and low humidity levels can brittle the fragile artifacts [7]. All published standards advice RH levels between 50% and 55% and temperatures between 16°C and 21°C. However, there might be specific variations between products of different categories. Museums should take care of these specific requirements and it is advisable to assign storage chambers to specific products as per their temperature and RH requirements. It might not be possible for smaller museums to create multiple storage chambers with specific temperature/RH levels, the key to

arrest decay lies in stabilizing the environment thus allowing artifacts to maintain long-term equilibrium with their surroundings.

Air conditioning the storage chambers is one of the most efficient means to maintain stable temperature/RH conditions. While this could be a de-facto option for established museums, smaller private & state-owned museums who do not have a robust revenue structure, might not be able to afford 24X7 air-conditioning because of its huge installation and running expenses. Additionally, centralized air-conditioning can be a potential risk as malfunctioning in one corner might pose risk to the whole collection. Thus, localized air-conditioning is a preferable option for museum storage. In absence of air-conditioning systems, such inner environment control can be achieved by humidifiers, dehumidifiers or simple heaters controlled by humidistats. In addition to the monetary requirements of an air-conditioning system, its maintenance costs and repair staff availability also needs to be considered before taking a decision.

7.4.2 Light

Light can be counted as the single biggest enemy of textile artifacts. It is a form of electromagnetic radiation that can be extremely damaging for textile artifacts, combined with other factors. Both visible & invisible components of light, i.e., Ultraviolet (UV) & Infrared (IR) have damaging effects on aged textile artifacts although their impact is different on different textile substrates depending on their age, fiber, types of dyes/finishes used, etc. It has been established by laboratory research that those certain fibers, weave types, dye molecules, etc., accelerate the process of degradation. This means that fabrics made of the same fiber but different weave type might age differently under the same duration and intensity of light [8, 9]. It is advisable to keep textile artifacts in dark storage, with illumination used only when required for the purpose of handling and maintenance. In this scenario as well, care should be taken to eliminate the UV component of light as it has no role in the illumination process and is invariably the most damaging component of light. UV light can be efficiently avoided by using ultraviolet filters with the light source. Natural light should be completely avoided in museum storage. Additionally, care should be taken to use the sources of light that emit as less heat as possible.

The damaging effect of IR light on textile artifacts could reflect in the form of color fading, fabric embrittlement etc. and these changes are completely irreversible. Therefore, it is paramount to restrict the duration and intensity of all types of light exposure to the artifacts. The light exposure to museum collections should be seen from a holistic perspective. This needs to take into account the unavoidable light exposures for conservation and exhibition purposes. Therefore, keeping collections in long periods of dark storage is an efficient means of reducing the cumulative damage done by exhibitions and stabilizing textiles towards a longer life-expectancy.

7.5 Storage Techniques

The guidelines for storage designs in museums are quite varied. More than providing direct instructions, it provides a framework of the dos and don'ts within which an ideal museum

storage must be designed. Some of the important pointers laid out by the guidelines stated in section 1.2 are as follows:

- All cupboards and containers should be clearly labelled
- Never place objects on top of each other
- All objects should be padded or supported using inert materials so that their original shape is retained. This is specially recommended for accessories like shoes, hats, fans, gloves etc.
- Trims and fastenings must not get crushed
- Boxes should not be over-stacked or over-filled
- Storage furniture should be designed in a way that it is safe and easy to work with for individuals. This can be achieved using inert materials & avoiding sharp edges
- All storage cupboards should be dust-proof
- Folding should be kept to minimum
- Folds if any, should be layered with acid-free tissues or knitted fabric stockings
- Folded textiles should be periodically unfolded and refolded to avoid damage at folds.

7.5.1 Accession and Labeling

When a museum acquires an object, it is given an exclusive and permanent code, typically a number, that is known as the accession number [10]. This number is unique and establishes the object's individuality and links it to its written collection records.

Museums have a location register that provides the exact location of any object in the collection. If the object is in the collection storage areas, it is critical that its exact location be specified. In order to describe its exact location, the storage areas must be systematically arranged and both the storage rooms and the individual storage systems should be coded and clearly labelled. Labels are an essential part of any object in the display or storage within a museum. As the objects in storage are packed and not visible, their recognition without touching is only possible through their labels. Thus, besides being essential for documentation purposes, labels also facilitate in locating and recognizing objects without handling them.

There are three basic types of storage—flat, rolled, and hanging textile storage [11]. These can also be classified into Horizontal orientation that includes flat and rolled textile storage and Vertical orientation that includes hanging storage. Museum handbooks advise flat storage for small textiles, textiles with pile structure, textiles with fragile surface, such as paint, textiles that are brittle and stiff and textiles with heavy surface embroidery and beadwork. Large textiles like carpets and coverlets are advised for rolled storage, and dimensional textiles like heavy costumes to be placed on padded hangers

7.5.2 Flat Storage

This is the ideal storage for most textile artifacts for various reasons. Flat storage does not add stress/strain to any part of the textile as there is no rolling or folding involved. Also, the gravitational pull is distributed all over the surface of the textile, thus saving it

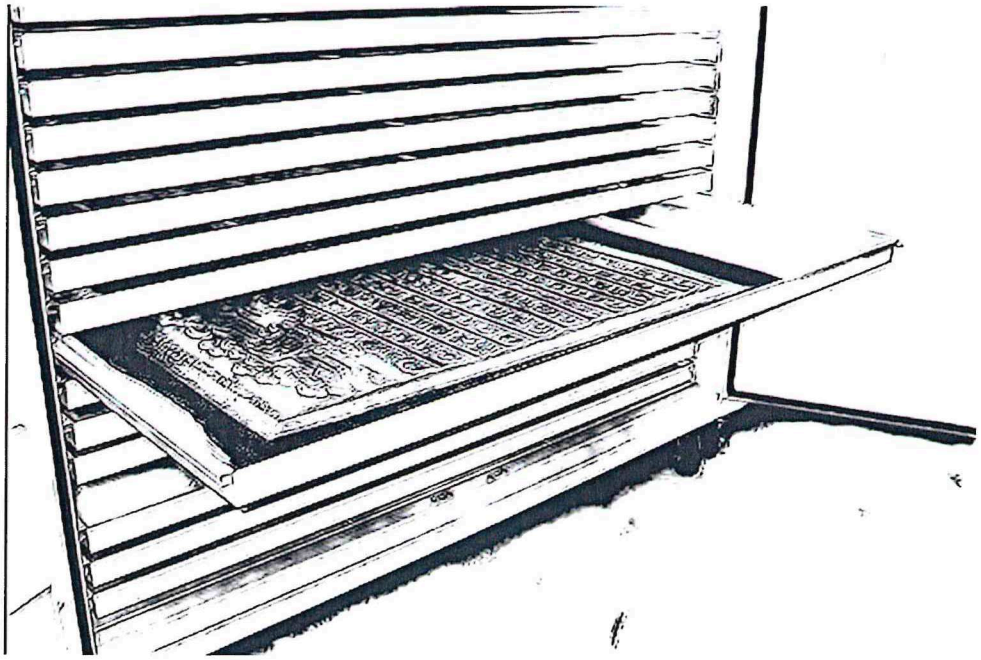

Figure 7.1 Flat storage drawers for textile artifacts.

from localized strains and weakening. Most hand-painted textiles, flags and regimental colors are laid out in flat storage (Figure 7.1). The textile is sandwiched between layers of acid free paper and placed in storage drawers made of non-corrosive material. The technique stands perfect for small size flat textiles and even costumes and made-ups to a large extent. However, it is not possible to store textiles of bigger size in this manner as it becomes practically impossible to create functional drawers beyond a certain size. Most organized museum storage sections would have numerous chests of drawers with thin sliding sections that contain one artifact each and can be completely slid out for easy removal and placement of the artifact.

7.5.3 Rolled Storage

This is a storage design where the artifacts have been nicely placed between layers of acid-free paper and rolled over non-corrosive rollers (Figure 7.2). This ensures that the artifact does not crease at any point of time, thus avoiding breakage at creases. Also, the fabric weight is distributed all through, with no undue pull of gravity at any one point. The technique stands just perfect for full length, open-width, unstitched textiles, like carpets, sarees, etc. It is advisable to use rollers with as large a diameter as possible, and the rollers should be longer than the width of the textile. It is important to ensure that these rollers have been made from acid-free materials and they are padded with inert materials. Once the textile has been carefully rolled over the roller beam, it needs to be then covered with sheets of acid-free tissue and dust-proof cover. However, this technique gets very complicated with costumes and made-ups as rolling over might place creases on parts stitched in various directions.

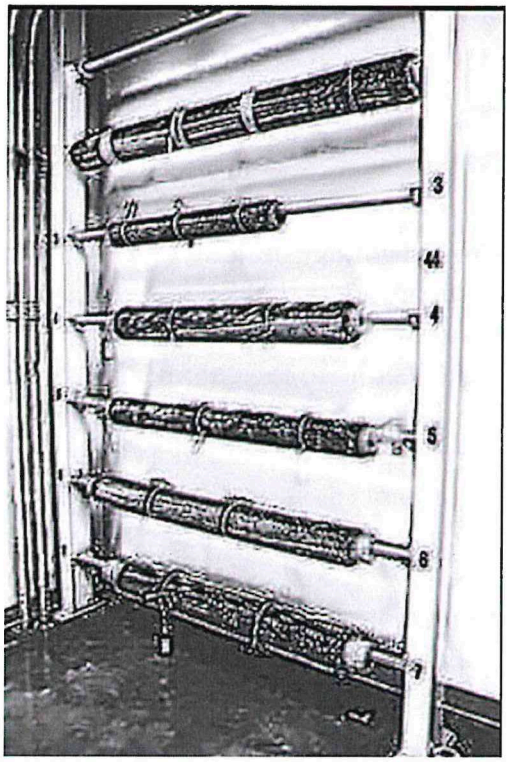

Figure 7.2 Rolled storage stands for textile artifacts.

7.5.4 Hanging Storage

Hanging storage is one of the most efficient storage designs in terms of space management. Additionally, it might be the only option for some design rich costumes that have significantly 3D designs and cannot be folded, rolled or laid out flat without compromising with the design/accessories. However, it cannot be widely used for most textile artifacts due to various functional reasons. Hanging storages concentrate the gravitational pull on certain central locations of the artifact, which can cause considerable wear and tear in those areas of the textile artifact. Although padding and support systems can be used to spread that pull over a larger area, it might still not be a viable option for already weak aged products. Keeping all this in view, hanging storage can be considered suitable for only very strong costumes using padded hangers that suit the individual features of the costume. This storage design should never be used for heavily decorated costumes or garments made from loose knits or bias-cut fabrics as these would gradually stretch out of shape.

Care should be taken to use wooden hangers and not wire hangers for hanging storage. Also, these hangers should be adequately padded with untreated polyester wadding covered with clean, washed calico. Polyester is the safest option for wadding/filling as it is stable, inert and does not absorb moisture like cotton or wool. It is advisable to create these padding covers as removable so that they can be washed occasionally. Care should be taken to design long neck hangers for costumes with high collars. It is also important here to understand that there cannot be a standard design or dimension for hanging storage hangers. Rather, each hanger needs to be designed and customized in-house taking into consideration the specific design features and susceptibility of the garment where extra support needs to be placed in areas that are already weak.

Like other storage designs, hanging costumes need to be protected from light, dust and crushing. Therefore, suitable covers from inert materials like well-washed cotton/inert bags or acid free tissues should be customized for each of these hanging costumes.

7.5.5 Special Storage

Apart from the above-mentioned storage designs, all textile museum storages need to make special arrangements for some products that do not find suitable space in any of the above mentioned due to their special characteristics. Artifacts containing fur, rubber, plastics etc. have special storage requirements due to the chemical activity associated with their degeneration process. Sometimes, they need customized storage designs; however, most of the time, these artifacts need to be separately marked as they have different maintenance routines or environmental requirements as compared to regular textile artifacts.

Textile exhibits that contain fur or feather trims have higher potential of pest infestations and need to be stored separately in colder temperatures in the range of 0-4 °C. Again, objects partially or wholly made of rubber might release Sulphur fumes in the process of degeneration and risk the exhibits stored nearby. It is advised to wrap these in barrier films and placed in oxygen-free storage if possible. Another common problem area is the plastics and lacquered leather. These can be found on costumes as accessories, buttons, patches, and in shoes handbags etc. Biggest problem with these artifacts is that each plastic has its own chemistry and thus a different deterioration curve. These objects are known to release plasticizers, organic acids and become sticky over a period of time. As the process is different from case-to-case, predictions are always not the best way out. It is therefore important to keep these pieces wrapped in acid-free packing and stored in well-ventilated rooms. Additionally, it is an established practice to store 3D artifacts on customized support platforms that can be used for both storage & display (Figure 7.3). This reduces the need for direct handling of artifacts and minimizes decay. This could include artifacts like headgear (hats, turbans etc.) or other textile articles like umbrellas, bags etc. As a standard practice, customized

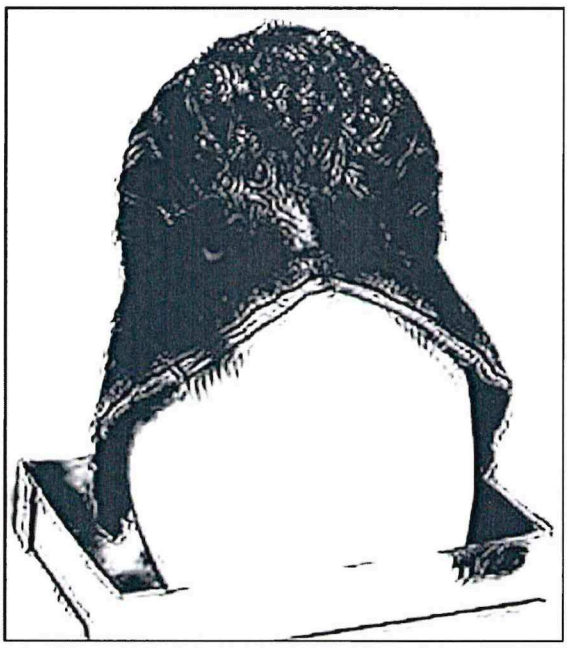

Figure 7.3 Customized support for a shaped headgear that works for both storage & exhibition.

shape supports are constructed for each artifact that provide support as well as help in dissipating the impact of gravity. The 3D storage mounts double as display mechanisms as well and thus ensure that the artifact does not need to be handled directly at any stage of display or storage [12–19].

Another interesting category of special textiles is the "Archaeological textiles." These artifacts are extremely fragile and require special care in handling. Archaeological textiles could be so sensitive that many a times these could disintegrate due to minimum handling required for research or exhibition procedures. Keeping this in mind, the textile fragments are often mounted on conservation safe frames that can be used for both exhibition and storage without any need for direct handling. This has necessitated three-dimensional mounting storage, which can be easily stored in boxes and can be made accessible without damaging the sensitive textile fragment [20–22].

7.6 Safety Systems

Museums are storehouses of timeless pieces of art that can be often priceless because of their heritage value, material or techniques. It is the prime duty of museum storage to keep these articles safe from theft and vandalism. It is desirable for museums to create and maintain a photographic record of all the objects with their specified location inside the storage areas. Museums have various systems in place to ensure security of the objects in their collection. Some of the most prevalent ones being physical protection by strengthening the building, perimeter alarms, invigilation, integrated electronic security systems and key security [23]. We will discuss the basic tenets of all these in the same order.

7.6.1 Location, Structural, and Physical Protection

The buildings meant to store museum artifacts should be designed in a manner that helps in defending or delaying an attempt of theft or vandalism. The building design and security layers around it should be able to delay unholy attempts enough so as to allow the alarm systems to react and gather support. Most importantly, the storage buildings need to have strong walls and roofs that cannot be penetrated easily. There should be a minimum number of doors and windows, just the minimum required for ventilation. Emergency doors should be equipped with quick-release functions. Also, access to the interior of storage chambers as well as the building roof should be restricted and regulated.

7.6.2 Perimeter Alarms

A perimeter alarm or intruder detector system needs to be installed across all openings of the storage building, such as doors, windows, roof lights, ventilation shafts, etc. Also, the system should be intelligent enough to reduce the false alarm rate. Systems relying solely on movement are liable to higher false alarms, especially in chambers designed for hanging storage. Ideal option is the alarm technologies that use a combination of movement and body heat parameters to detect untoward movements. Additionally, there needs to be an active, round-the-clock protocol to address the signals raised by these alarm systems.

7.6.3 Invigilation

Manual monitoring of the storage systems is necessary to ensure total safety. It is important to regulate access to museum storage chambers by restricting access to only authorized personals and creating a log of people entering or exiting the building. Also, any visitors, researchers requesting access for academic or administrative reasons, need to be accompanied by authorized professionals at all points of time. Invigilation professionals need to be extra vigilant during specific times like evening events or when an exhibition is being installed or uninstalled.

7.6.4 Key Security

Museums need to design and administer strict protocols regarding the use and possession keys to the storage areas. It is advisable to have only as many sets of keys as strictly required, and these should be actively logged and accounted for. Under any circumstances, museum staff should not be allowed to take internal keys out of the building. Modern electronic key systems can maintain auto logs of every single use and help in monitoring access to the storage chambers. Nevertheless, any theft or security breach should be immediately reported to local authorities.

7.7 Disaster Handling

Despite all measures taken, it is not unusual for museums to face unexpected situations like floods, fires, pest infestation to name the few. Disaster handling in museums essentially needs to be discussed under two categories, i.e., (a) Disaster potential management, (b) Disaster response. Museums need to have a well-laid policy and protocol for handling these situations and thoroughly train its professionals to handle these situations. Every museum needs to have a well-written detailed disaster plan document to lay out an action plan for disaster prevention and management. This plan document should essentially start with a discussion on *Risk Assessment* where a thorough and practical assessment of all imminent risks should be made. Although all museums need to be ready for all kinds of emergency situations, some museum storage will be more prone to certain disasters than others. For e.g. A museum or museum storage situated close to a major river needs to proactively plan for potential flooding than any other disaster whereas a museum located in a desert area faces almost negligible chances of such an episode. The disaster management document needs to take the assessment forward by laying out risk mitigation procedures. It needs to detail a clear policy in times of emergency in terms of items that need to be rescued on priority. This plan should contain updated emergency contact numbers as well as the contact details of public emergency services. It should also detail the responsibilities of specific personnel at the time of emergency and a road map to crisis management. It should contain a clear, confidential up-to-date plan of the building marking all areas, big or small. The plan should also contain a complete record of the collection with prioritized items marked in the document and the collection covers. Although this information is already available in museum registers, access to this information in the disaster plan document might save valuable time and facilitate quick action. It should further elaborate upon the safety policy for working in hazardous crisis conditions and an emergency security policy in case the premises have been damaged. All storage areas should be equipped with disaster boxes to be used during an emergency. One of the most important parts of this document

could be the prescribed first-aid measures drawn up in consultation with conservators. The staff needs to be regularly trained on emergency disaster response drills.

7.7.1 Protecting from Fire

Risk of damage due to fire can be both direct or indirect like melting/burning of mannequins etc. Disaster management in terms of protection from fire can be discussed under two aspects: (a) prevention through design and practice, (b) emergency response at the time of disaster. A well laid out policy in both the scenarios and regular training of museum professionals to help them put the plan into practice complete the circle of protecting the artifacts from fire.

Prevention is an ongoing aspect of disaster management that is intertwined with every aspect of museum building, care and maintenance. Museum buildings should be architecturally designed and physically constructed in a manner that minimizes the risk of a fire hazard. The architecture of the building should essentially include an adequate number of fires exits and emergency outlets for ventilation. The building needs to be equipped with fire warning and safety and firefighting equipment. Adequate numbers of water sprinklers and carbon dioxide-based fire extinguishers (more preferable than water-based fire extinguishers for textiles) need to be placed and regularly maintained. Museum area storing collections should be rigorously insulated to provide at-least one hour protection from fire. This guidance is based on the assumption that it might possibly take firefighters that much of time getting into action. Also, a building should be planned in a way that high risk areas, such as laboratories, kitchen, boilers, or chemical stores are placed away from the storage chambers. All these factors need to be kept in mind while detailing the placement of fire sensors across the building. As far as possible, the materials used in construction of buildings and their interiors should be fire-resistant. All electric, gas and oil installations or equipment should be done as per prescribed standards and a copy of the wiring plan should be included in the disaster management document. Museum buildings should comply with all safety legislations and should be duly certified by local fire departments after regular inspections.

Artifacts that are known to be made of cellulose nitrate like bags, buttons etc. should be identified and monitored. These should be kept in special storage to prevent build-up of harmful gases. It is advisable to maintain a copy of all museum records & documentation in a separate building. Smoking should be forbidden in and around storage areas. Careful thought should be given while planning exhibitions & concerts. Additionally, any construction or repair work on premises that involves working with heat sources, such as blow torches or arc welding, should not be permitted in the vicinity of storage areas.

Above all, it is imperative that staff & volunteers are given regular training in preventing & responding to fire hazards.

7.7.2 Protecting from Floods

Interestingly, "Museum & Galleries Commission's Book of Standards" advises museums to make arrangements assuming, "If a flood can occur, one day it will." This statement emphasizes the readiness with which museums should keep themselves ready to face adversities. It also wants to explain that although calamities occur once in years or maybe decades, if caught unprepared, they might wipe out the efforts made in developing and managing a museum collection over the long preceding years. Although the occurrence of such

incidents is rare, its damage potential is huge and therefore worth mitigating the risk by a suitable disaster management plan.

The policy towards flood management is not limited to flood caused by overflowing water bodies nearby, but includes any damage potential by aqueous functions like plumbing lines, fire lighting equipment, etc.

It is advisable to store textile artifacts in buildings that have possibly no pipe works, at least in areas where collections are to be stored. It is always expected that the storage cabinets are at least 150 mm (6 inches) above the floor. In buildings, where it is not possible to exclude the pipe-works altogether, one solution could be to run the pipe work at ground level instead of ceiling level or side walls. Nevertheless, adequate drainage should be provided in all chambers. Also, automatic cut-off valves and leak detectors and flood detection alarms should be adequately installed. Dangers of leaks from humidifiers should also be considered. Advice should be taken from local bodies about the likelihood of floods & buildings susceptible to floods should have adequate equipment like bund walls, stop-boards & sandbags etc.

The disaster response plan should contain detailed information about pipe-works & stop-cocks around the building. All drains should have non-return taps & all taps in sinks should be spring loaded, auto-turn off type. The plan should also consider the danger of water damage from fire hazards or flooding danger posed by central heating systems. Care should be taken to protect all racks and shelves with water-proof sheeting at all times, however, not using materials that can accelerate other forms of deterioration by creating microclimates. As valid for all other possibilities, the disaster boxes should contain adequate equipment for dealing with floods, including absorbent pillows and super slurpers [24]. Finally, regular and thorough staff and volunteer training stands imperative to success of any of these flood management plans.

7.7.3 Protecting from Pests

Biggest biological threat to museum collection apart from people is from rats, mice, birds, insects, fungi, algae and bacteria. Although some of these can be effectively barred from coming in contact with the housed collections by physical arrangements, some of them cannot be monitored by simply denying access. The threat is such that the introduction of one infested piece in the storage chamber can effectively trigger havoc for the whole collection. Therefore, it is imperative that all incoming objects, together with their packaging material should be inspected in a separate quarantine room for the presence of any biologically active agents. Some museums follow a policy of quarantine and sanitation by prescribed treatments immaterial of the inspection reports [25].

7.7.4 Day-to-Day Maintenance

Regular inspection and maintenance procedures further ensure safety of textile artifacts from these pests. Placing pest traps in storage areas is a time-tested strategy that should be followed. Museums should develop and follow an Integrated Pest Management (IPM) strategy that details methods of quick and effective eradication in case of an outbreak.

The biocidal remedial treatments to eliminate pests should be kept to minimal as these can be potentially harmful to the objects, environment, staff and visitors. Some of the old techniques include widespread fumigation of storage chambers with pesticides or use of

naphthalene balls. However, these techniques carry long-term health risk for museum workers and also the fumes might cause color fading in textiles over a period of time. A range of new pest control methods have since been developed that are safer for both the workers and the stored objects. One of the most effective treatments prescribed is timed exposure of textiles to carbon dioxide or nitrogen chambers. This process effectively kills/deactivates the microorganisms and sanitizes artifacts for a very long time. Some manuals also propose heat treatments or freezing treatments for sanitization. However, these might not be conducive for textile artifacts given potential damage in terms of burn marks or color bleeding respectively. Many museums in India have been managing their collections effectively while using herbal remedies like *Neem* leaves, spices and condiments. Since textile artifacts have varied susceptibility, the remedial disinfection process should be duly discussed with the conservation scientists before practical application.

7.8 Managing Dust and Dirt

Dust and dirt need to be regularly managed in order to keep the collection in healthy condition. Dust can originate both from internal and external sources and if left unattended, it can fasten deterioration by attracting and holding moisture. These basic nuances are capable of fostering mold growth and attracting pests and other microbiological infections. Therefore, all storage areas should follow a regular cleaning regime, which is monitored by trained and experienced museum professionals. Good housekeeping is the key to preventing dust-initiated damage to artifacts. However, housekeeping protocols for a museum storage can differ from that of a regular public premise. Wet cleaning of museum storage floors can disturb the stability of humidity levels and further encourage deterioration of the products. It is advisable to use vacuum cleaners for cleaning the storage interiors while completely avoiding wet cleaning if possible. Also, care should be taken that vacuum cleaners have been properly maintained and not using the same attachments as used in some other pest infested areas.

Storage area windows, if any, should be close fitting and kept shut and floors should be covered or sealed. All costumes and textiles should be covered with dust sheets. Also, there should be loop-piled door mats and under door brushes at the doors to the store. Additionally, care should be taken to keep the curtains and dust covers clean by regular laundering. There should always be additional dust covers available when one set goes for laundry. It is important to use only those cleaning methods and equipment that are approved by the conservators and collectors. Special precaution should be taken to temporarily relocate the collections in case of building works in vicinity. It needs to be duly mentioned here that sometimes the dirt acquired becomes part of the history of the object due to certain circumstances. This aspect should be duly considered and discussed with the collectors before an object is cleaned.

7.9 Pollutants

Pollution is a widespread term used in different perspectives. Pollution can be broadly described as the introduction of harmful elements in the environment. Museum artifacts in storage suffer from pollution risks both from indoors and outdoors sources.

The impact of outdoor pollutants is directly proportional to the rising pollution levels of the city or local area. Harmful elements, such as sulfur dioxide, ozone and nitrogen dioxide, smoke, dust deposits from diesel fumes, etc., can cause fading, staining, and deterioration of both organic and inorganic objects. Needless to say, organic artifacts like textiles are impacted much higher as compared to the inorganic ones. The impact of outdoor pollutants can be significantly reduced by draught proofing doors and sealing windows. Additionally, mechanical ventilation equipment with scrubbers and charcoal filters can assist in reducing the impact of outside pollution.

A potent and continuous indoor source of pollution could be the materials in the immediate environment of the artifacts. Storage construction materials like boards, hard wood, fire-retardant coatings, paints and adhesives, and some artifacts themselves, like the ones made of wool fur might be constantly emitting small amounts of vapors and gases that might accelerate the deterioration of adjacent textiles. Although good ventilation minimizes this risk, enough time should be allocated to testing of all materials before they are used in the storage chambers. "Oddy tests" are routinely used by museums to test materials that come in close proximity to the stored objects. These tests use metal coupons that have very reactive surfaces. These metal coupons are placed in a closed vessel with a sample of the fabric, which is to be tested. Any resulting corrosion to the metal coupon indicates the type of pollutant being given off by the material. For example, if a silver coupon tarnishes, then a sulfur compound is being given off. The test takes up to 6 weeks to complete.

As noted earlier, the stored artifacts and their accessories could themselves become potent sources of pollution in a storage chamber. Metallic fastenings are one such notorious category. It is for this reason that only *Velcro* covered with unbleached fabric is considered safe for museum textiles. Additionally, objects containing rubber (such as elastics, carpet backings, raincoats, shoes, etc.) release sulphur into its surroundings that can cause adjoining fibers to disintegrate and metallic inclusions to erode. Plastics present as buttons, etc. release plasticizers over the period of time, which can cause similar damage to adjoining fibers. Metals present as buttons, sequins, metal threads can tarnish and corrode and their corrosion products can accelerate degeneration in the surrounding fabrics. Some combs, buttons, buckles might be made of cellulose nitrate that gives off corrosive acidic products at ageing. Also, glass beads used as embellishments on dresses can also be chemically unstable, as well as easy to break and may affect the underlying fabric by bleaching it or damaging the yarns. Interestingly, another hidden category of indoor pollutants is the remnants of chemicals used in the production, finishing, and treatment of fabrics from previous conservation treatments.

Another important source of indoor pollutants is the building works and redecoration works. These can introduce contaminants, such as dust, paints, solvent fumes, and large quantities of moisture, which are potentially harmful to the objects. Building and finishing materials emit particles like saw dust along with ammonia and water vapors for some time after application. Therefore, a newly built or redecorated building should be ventilated and completely dried using industrial dehumidifiers. Care should be taken to not store objects in newly decorated space until tests show that emissions have been reduced to acceptable levels.

7.10 Conclusion

Museum storage has become a central issue for museum policies as significant parts of collections are kept in storage. Textiles being fragile and hygroscopic in nature are extremely susceptible to damage from many factors. They need to be given special attention within the storage of museums. Improper environmental conditions surrounding the artifacts in storage spaces affect the rate of textile deterioration. Natural disasters, fires, and earthquakes being other conditions, which have been a major concern for the museum professionals. It can be safely concluded that stabilized storage conditions in terms of humidity and temperature play a decisive role in long-term preservation of textile artifacts. Storage spaces need to be inspected regularly to ensure minimal stress on the housed collections and keep them safe from weather, pollutants, pests, dust and dirt, and other external threats. Safe storage furniture materials that are inert and do not rust or oxidize and are also dust proof should be used for storage of textile artifacts to protect them from many damages that are associated with material types. Where technology has a huge role in maintaining optimum storage conditions, museum architecture plays a crucial role in maximizing the benefits of technology for the protection of cultural heritage. There cannot be a standard solution that can effectively take care of maintenance needs of varied textile artifacts. Each textile artifact in museum collections need to be carefully analyzed in terms of condition, components, etc. to be able to decide the best possible storage regime for it. While ensuring a longer lifespan for textile artifacts could be both labor- and resource-intensive, their cultural importance could well justify the time, effort and resources spent in their careful storage and maintenance.

References

1. Sachdeva, K., Suri, M., Bhagat, S., An overview of Textile Conservation Practices in Museums of Australia, in: *Conservation of Cultural Property in India*, 2009.
2. https://www.iccrom.org/sites/default/files/RE-ORG%20Leaflet%20A4%20-%20for%20printing.pdf, 2020
3. Kreplak, Y. and Mairesse, F., Museum collection storage. *Mus. Int., ICOM*, 73, 1-2, 1–4, Routledge, 2021.
4. *Standards in the Museum Care of Costumes & Textile Collections*, Museums & Galleries Commission, UK, 1998.
5. https://backend.orbit.dtu.dk/ws/files/131863954/2016_04_ACE_2016_New_Concept_for_Museum_Storage_Buildings_Christensen_Knudsen_Kollias.pdf, 2021
6. https://philamuseum.org/conservation/5.html?page=3, 2021
7. Sachdeva, K., Suri, M., Bhagat, S., Assaying changes in museum textiles on ageing-A short note, in: *Conservation on Cultural Property in India*, vol. 39, pp. 119–122, 2011.
8. Sachdeva, K., Suri, M., Bhagat, S., Effect of fabric construction on the longevity of aged cotton fabric. *Int. J. Eng. Res. Appl.*, 10, 9, 49–61, 2020.
9. Sachdeva, K., Suri, M., Bhagat, S., Role of fibre in degeneration of aged fabrics in museums. *IJERASET*, 531–539, 2021.
10. https://unesdoc.unesco.org/ark:/48223/pf0000042316, 2021.
11. https://www.spacesaver.com/portfolio-posts/designing-off-site-museum-collections-facility/, 2021.

12. https://collectionstrust.org.uk/wp-content/uploads/2017/02/Museums-Galleries-Commission-An-Illustrated-Guide-to-the-Care-of-Costume-and-Textile-Collections-2000.pdf, 2021.
13. https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/canadian-conservation-institute-notes/storage-costume-accessories.html, 2021.
14. http://insidetheconservatorsstudio.blogspot.com/2017/10/conserving-storing-and-mounting-hats.html, 2021.
15. https://www.mfa.org/collections/conservation/feature_costumeaccessories_hatsandheadware_carved, 2021.
16. http://museum.wa.gov.au/research/collections/materials-conservation/care-wa-museum-collections/storage-19th-century-bonnets-2, 2021.
17. https://artsandculture.google.com/exhibit/conservation-in-action-preserving-hats-and-head-wear-at-the-mfa-boston-museum-of-fine-arts-boston/wAKCMTQv7r5NKA?hl=en, 2021.
18. https://americanhistory.si.edu/blog/2011/06/out-of-storage.html, 2021.
19. https://www.airforcemuseum.co.nz/blog/military-headgear-conservation/, 2021.
20. Peacock, E. and Griffin, E., Rehousing a collection of archaeological textiles. *Conservator*, 22, 68–80, 1998.
21. http://resources.culturalheritage.org/wp-content/uploads/sites/8/2015/02/osg008-012.pdf, 2021.
22. Childs, S.T. and Benden, D.M.A., Checklist for sustainable management of archaeological collections. *Adv. Archaeol. Pract.*, 5, 01, 12–25, 201.
23. http://ignca.nic.in/Museum_security2013/museum_security_proceedings01.pdf, 2021.
24. Amaral, J.R., Thinking inside the box: evaluation of polypropylene boxes for the storage of museum objects. *Conserv. Patrim.*, 34, 1–23, 2020.
25. Faheem, F., Management of pests risks in museums: A review. *Int. J. Adv. Res. Biol. Sci.*, 122–136, 2019.