



General Problems Found in Deteriorated Paper Documents and their Causes

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Abstract: India is a tropical country, where weather is always fluctuating. This fluctuation generates a variety of problems in stored and displayed paper based material and is a big reason why large collection of paper documents have been previously destroyed and are actively being damaged every day. Paper is organic in nature and very sensitive to environmental and biological factors. Acid is detrimental for paper documents, it makes them weak and brittle and can further lead to discoloration, deterioration, and can cause irreversible damage. Other factors that affect the life of paper documents include the manufacturing process, paper components, and inks/pigments that are applied to the paper. It is important to create a safe environment for paper documents to keep these elements from destroying them.

Index Terms - Conservation, Problems, Paper documents.

I. INTRODUCTION

While archives, libraries and museums all have a rich repository of paper documents (manuscripts, books, map, graph, poster etc.), even all religious places of worship in India all have their big collection of rare manuscripts. Being organic in nature these objects are inherently more susceptible to inevitable and irreversible decay in due course of time as well as due to various deterioration factor. The field study reveals that stickiness, folds and wrinkles, damaged spine and stains due to colour, water, ink, blood, adhesive, etc. are the main problems found in these paper materials. Moreover fungus and fungus stains, brown stains, brittleness, broken edges, damages due to insects, acidity in paper, ink and adhesive, porosity of paper and faulty conservation processes, etc. are also found in different places in India.

II. PROBLEMS OF DETERIORATED PAPER DOCUMENTS

Paper objects deteriorated over a period of time face multiple problems caused by acidity, fungus, insect, rodents, mishandling, poor conservation techniques, natural disasters and so on. While some problems may happen quickly such as abrasion, tears, folds, loss, etc. however maximum problems arise in the paper object over a slow period of time like foxing, buckling, bulging, brittleness, etc.

There are following problems found in the paper documents-

Abrasion- An area of paper document, where media or substrate fibers have been lost due to rubbing or repeated friction (Fig. 1).

Abrasion of ink and pigments- Loss of surface of ink and other pigments due to repeated rubbing (Fig. 2A and 2B).

Accretion- An opaque substance overlaying on the surface rather than impregnating the substrate fibers.

Bleeding of ink or pigments- Running of the colorants within the media (Fig. 3).

Brittleness- Overall weakness of the paper, caused by inherent acidity of the material, which can result in its snapping, cracking, or breaking during handling (Fig. 4).

Buckling- A soft curved random distortion in paper documents. It also describes the uneven surface or rippling effect occurring on a paper.

Bulge- A convex concentric expansion at the paper documents caused by humidity (Fig. 5).

Cleavage of the surface layer- Low temperature and high humidity causes a defect of cleavage of the surface layer of the paper documents. This happens due to the breakdown of the bond between the surface layer and other parts of the paper.

Cracking- A series of cleavages resulting from either the different rates and degrees of expansion and contraction of components within the medium and the substrate, usually induced by fluctuating relative humidity (Fig. 6).

Crease- A line of crushed or broken substrate fibers of the paper documents, the result of a fold which may later develop in to a tear (Fig. 7).

Damaged spine in case of bound volume- It is a major problems in old books and manuscripts. Acidic adhesive, weak thread, acidic material (such as cloth, board and end paper, etc.), rounded spine, mishandling, improper stitching, improper photocopy and scanning etc. are the main reasons for the damaged of spine of a book or manuscript (Fig. 8).

Delamination- A separation between layers of the substrate of paper documents and its support (Fig. 9).

Dent- On concave impression at the paper documents caused by force.

Dimpling- A local distortion, usually at a corner, marked by a distinct concave area of the support surrounded by a raised crease or soft convex curve of the support, usually caused by a local adhesion of the support to the secondary support.

Discoloration- The paper documents become yellowish, brownish or sometime blackish. The main cause of discoloration is due to oxidation and accumulation of dust. The paper documents turn yellow or brown with the passage of time (Fig. 10).

Dog-ear- A local damage at the corners, with multiple folds and creases in the paper documents (Fig. 11).

Draw- A local distortion at a corner, marked by diagonal cockling from the corner toward the center of the support, usually caused by tension from a corner mounting of the support to the secondary support.

Dust and dirt- Fine dry particles of any matter present in the air are known as dust. Dust, which is highly dangerous for the paper documents, composed of soil, tar, metallic substances, fungus spores and moisture among other things. Since dust is air borne it settles down on the surface of the paper. Dust is hygroscopic in nature and when it is mixed with high humidity, it is transformed into dirt and if this dirt sticks to the surface of the books, it becomes difficult to remove. Dust and dirt are sources of both physical and chemical degradation of the paper documents. Dust acts as a nucleus around which moisture collects and this moisture provides the necessary humidity for the growth of fungus and for chemical reaction, which lead to the formation of acids. Since dust and dirt are solid particles of varying size and hardness they exert abrasion on the surface of the books.

Dull spot- A matte area of paper documents which may be caused by water, dry-cleaning, etc.

Fading of ink and pigments- Fading of ink and pigments is common problem. Abrasions, frequent handling, effect of light result into fading of ink and pigments from the paper documents.

Finger prints- Greasy or dirty marks absorbed into the substrate fibers. Finger prints are generally found on the corners of the paper (Fig. 12).

Flaking of media- Continuing loss of media, usually preceded by curling or "cupping" of sections of the media, and resulting from a weak initial binding or delamination between media and support.

Folds- Improper storage, mishandling, folded pages for identification, round spine and human vandalism are the main reasons for folds in any type of paper (Fig. 13).

Fragility- Overall weakness of the paper documents caused by handling, which can lead to immediate tearing (Fig. 14).

Hole- A puncture in the paper materials which may be caused by tacking, pin-pricking, insects, etc (Fig. 16).

Light staining- Light staining is caused by the penetration of UV light on unprotected paper.

Loss- A void caused by loss of the paper documents either inside or outside the substrates original perimeter (Fig. 15).

Mat burn- Darkened line paralleling the bevel of a window on paper documents resulting from volatile acids emanating from an acidic inner core of the documents.

Scar- A compressed scratch from which fibers are not lost but an impression is left.

Scratch- A scrapped line in the paper documents which results in the loss of fibers (Fig. 17).

Shine- A glossy area in the paper documents caused by accidental burnishing (Fig. 18).

Skin- An area of paper document, where the substrate surface has been removed in a uniform thin layer which may be the result of tape removal or sticking of the substrate to some surface.

Soot- Greasy, blackish grime resting lightly on the surface of paper and resulting from atmospheric pollutants (Fig. 19).

Splitting of the surface layer- Variations in the environmental conditions result in the splitting of the surface layers and as a result cracks appear on the surface of paper documents and the ink flakes off at the splits. Tears are found on the paper documents due to the weakened structure.

Split- A soft-edged, linear break in the substrate of the paper documents caused either by a contraction of restricted paper or the rupture of the paper along a worn crease or fold.

Stains- Any color change perceived as lying within the substrate fibers rather than on top of them. There are many type of stains found in paper materials such as color, water, ink, blood, adhesive and rust etc. Some paper documents have one or more stains. Sometimes stains are visible on the text and sometimes on blank portion. Faulty storage conditions, contact with water, dust and dirt causes the stains on the paper documents (Fig. 20 A, B, C). Stains may be categorized as:

- Oxidation stains- Yellowing along the edges of the substrate of any paper documents from marginal exposure to air, as seen on book pages or the edges of framed items.
- Wood burn- Darkened areas resembling wood grain or knot holes in the paper documents resulting from acids and resins present in wooden slats used as frame backs. It may also appear as one or two brownish lines across the substrate indicating where the slats met.
- Water stain- A broad stain caused by movement and deposition of discoloration products carried in an aqueous solution and distinguished by a dark, curvilinear tide-line along the point of evaporation.
- Oleaginous stain- A stain caused by an oily or resinous substance.

Stickiness- There are all sorts of reasons for pages getting stuck together and even the whole book becoming unopenable. The most usual reason is the object being accidentally soaked in some liquid. High humidity in the environmental conditions is another usual reason. Since paper is prepared with sizing material (adhesive), which reacts and dissolve with water or any type of moisture, after drying the water or moisture in the sizing material of each page stick together (Fig. 21).

Tape or hinge staining- Tape or hinge staining is darkened areas left by tape, hinges, or glues (Fig. 22).

Tear- A soft-edged, irregular rip in the substrate of the paper documents which may have overlapping edges, and can be characterized as branched, accordion pleated, ragged, etc. (Fig. 23).

Tide line- Tide line is caused by water polling on the surface of a paper document.

Toning- Toning is discoloration due to fumes emanating from acidic material.

Trim- Mechanical reduction of the edges of the paper documents by cutting.

Warp- One over-all concave/convex curve the paper documents (Fig. 24).

Wrinkling- An angular, crushed distortion in the paper documents.

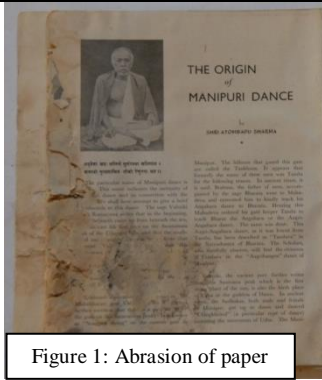


Figure 1: Abrasion of paper

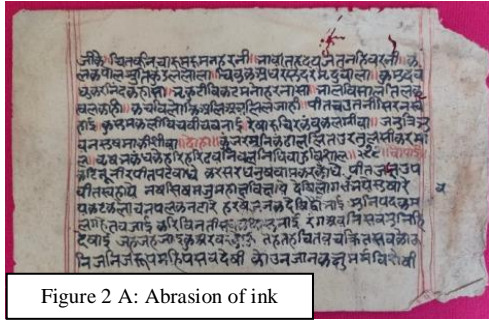


Figure 2 A: Abrasion of ink

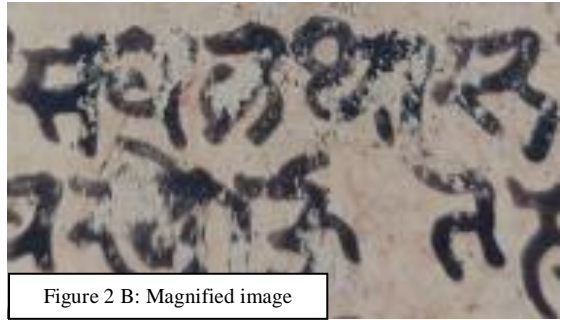


Figure 2 B: Magnified image



Figure 3: Bleeding of ink



Figure 4: Brittleness



Figure 5: Bulge

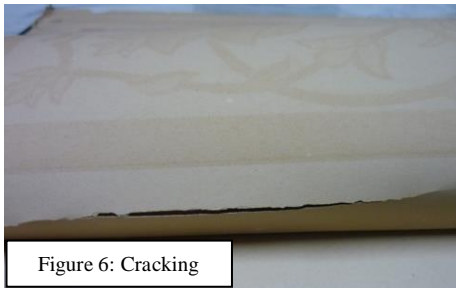


Figure 6: Cracking

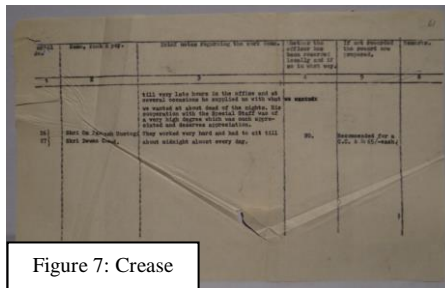


Figure 7: Crease



Figure 8: Damaged spine

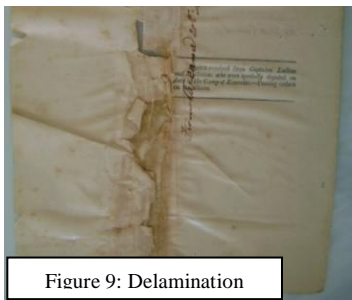


Figure 9: Delamination

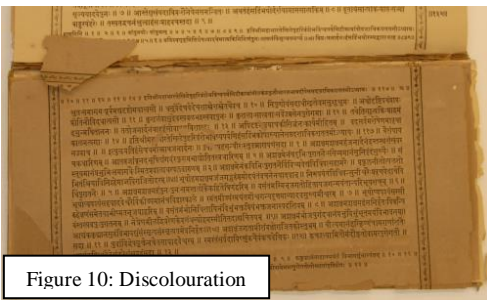


Figure 10: Discolouration

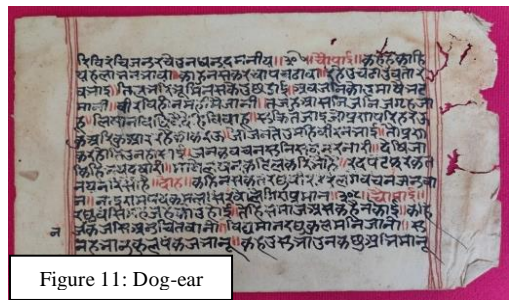


Figure 11: Dog-ear

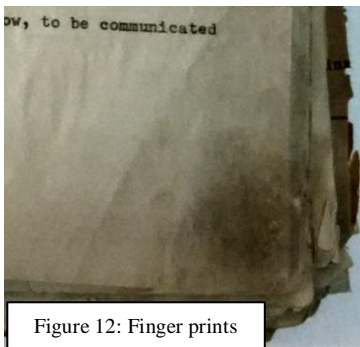


Figure 12: Finger prints

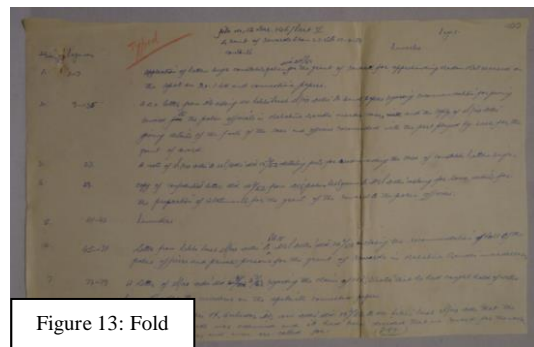


Figure 13: Fold



Figure 14: Fragility

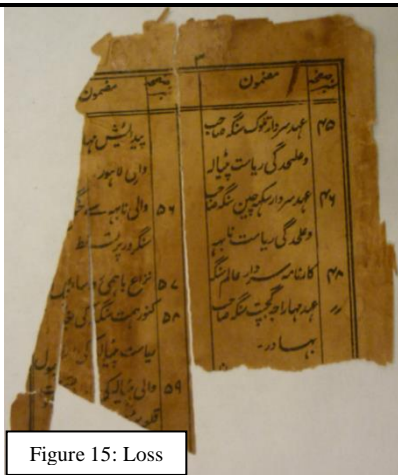


Figure 15: Loss

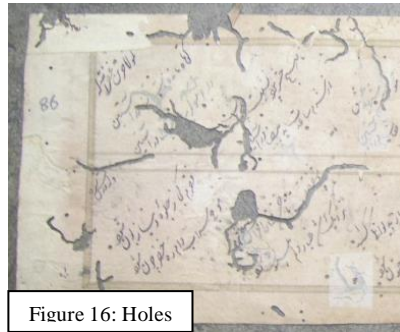


Figure 16: Holes

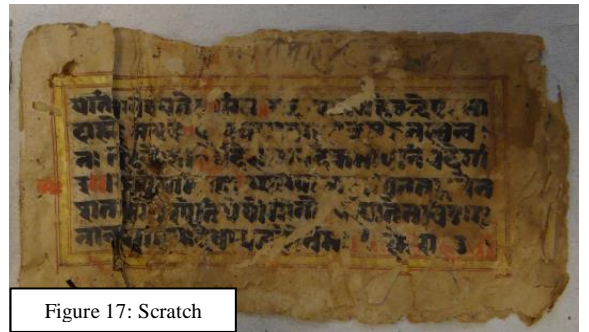


Figure 17: Scratch

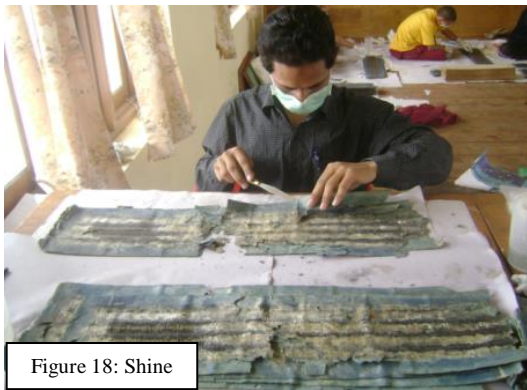


Figure 18: Shine



Figure 19: Soot

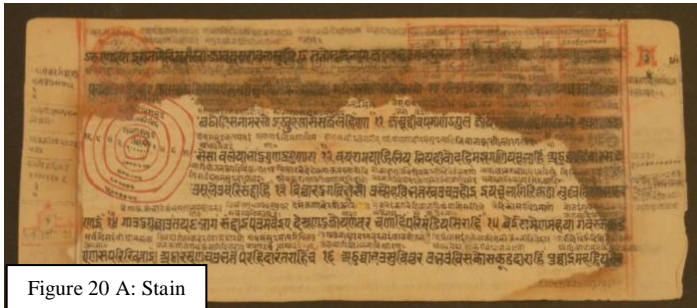


Figure 20 A: Stain

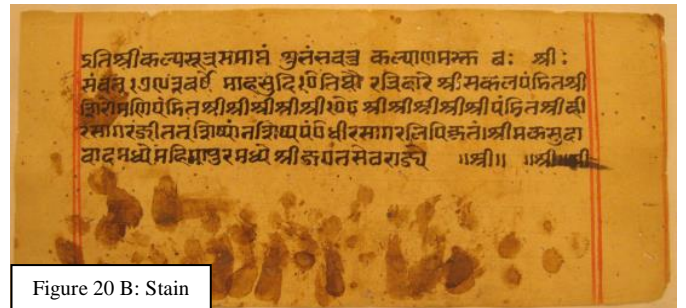


Figure 20 B: Stain



Figure 20 C: Stain



Figure 21: Stickiness



Figure 22: Tape staining



Figure 23: Tear



Figure 24: Warp



Figure 25: Damaged by insects



Figure 26: Damaged by fungus

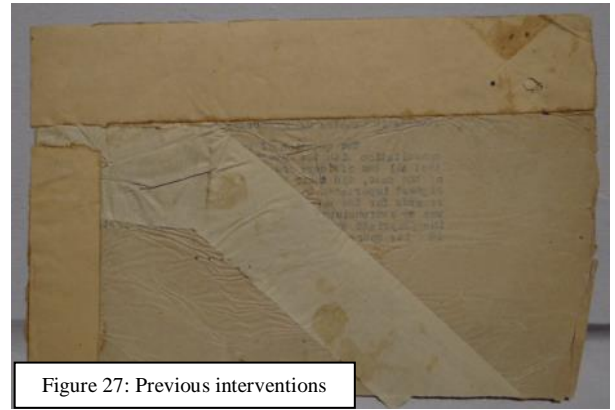


Figure 27: Previous interventions

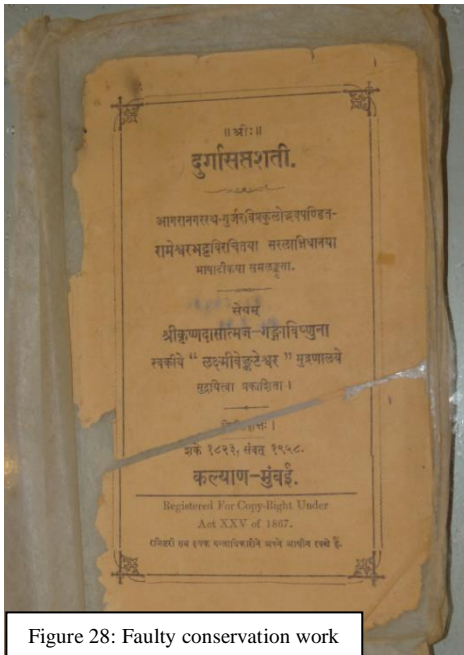


Figure 28: Faulty conservation work



Figure 29: Faulty conservation work

III. CAUSES OF DETERIORATION OF PAPER DOCUMENTS

There are following causes of deterioration of paper documents-

Acidity- Acidity is one of the main causes of deterioration of paper. Due to hydrolysis of cellulose and lignin some salts/organic acids generated in the paper produce excess hydrogen ions and the result is the change in the nature of paper in terms of its durability. The phenomenon caused by this problem is known as acidity. Sources of acidity in paper are acids involved in manufacturing of paper, acids produced during aging processes of paper and acids absorbed from various pollutants. Weakening, brittleness, yellowing are the main problems caused by the acidity.

Foxing- Cellulose and gelatin size of paper attract fungi in presence of high relative humidity. The paper documents become yellow colored and stained with colored spots. Some micro-organisms live on sizing material while some on cellulose fibers of the paper. The affected area becomes absorbent like a blotting paper. Again, in presence of cellulytic micro-organisms, the surface of paper becomes eroded and it becomes brittle. Moreover, iron salts are accumulated on the affected areas and leaves rusty brown spots. This is known as 'foxing'.

Fungus- Fungi require the following for growth: a food source, an appropriate level of moisture in the material and in the surrounding air, and an appropriate temperature. Coastal rainforests are ideal habitats for fungi. The humidity in the air is often close to that required for growth, usually estimated to be around 60% to 65% relative humidity at room temperature. Fungal growth is very common in case of paper documents resulting into black or green spots on paper documents.

Mold may be visible as a fluffy, colorful live cluster of filaments, or a stain with inactive spores, or may be practically invisible except when examined in ultra-violet light. Mold attack may be evidenced by a spongy, friable area of the substrate, caused by a weakening of loss of sizing material (Fig. 26).

Insects and Rodents- Large collection of paper documents have been damaged due to loss substrate surface (insect grazing) in a pattern of meandering channels caused by attack of silverfish, cockroaches, etc., loss of the entire substrate (wormholes) from channeling by bookworms, etc., loss of the entire substrate with a serrated edge pattern (mouse chew) from rodent attack. High temperature and humidity and man's negligence also favor the growth and proliferation of insects. The following manifests such negligence:

- Accumulations of dirt and dust from poor or careless housekeeping practices,
- Introduction of foodstuff to storage and exhibit areas,
- Entry of insect-infested items into the collection,

- Open windows, air vents or poorly sealed windows and doors,
- Unattended roof leaks and cracks in a deteriorated museum building, and
- Poor ventilation.

Rodents and insects are the worst enemies of books and other organic materials that are cellulosic in nature. The materials contain proteins and carbohydrates in the form of sizing, paste or starches, and other organic substances attractive to insects. The nature and extent of the damage depend not only on the insect and material, but also on how promptly the infestation is discovered and controlled. Damage may vary from a few holes to complete destruction (Fig. 25).

Previous intervention and faulty conservation- Large collection of paper documents have been restored using inappropriate material by unprofessional conservators such as mending with newspaper strip, brown paper strip, cello tape, brown tape, masking tape and paper tape etc. and lamination with cellulose acetate foils, lamination with butter paper etc. All these materials are extremely harmful for the already sensitive paper documents. Multitude of paper documents in the form of manuscripts and rare books have been destroyed due to cellulose acetate foil lamination (Fig. 27, 28 and 29). Generally untrained staff used following tape or adhesive for the reaping of paper documents-

- Pressure sensitive adhesive tape: Plastic, cloth, or paper backed adhesive which is removable only by chemical and may cause running of the media and staining, translucency, and skinning of the substrate. Examples: Scotch branded tape, masking tape, carpet tape etc.
- Water-activated adhesive tape: Cloth or paper backed adhesive tape which is reversible in water and may cause impressions and staining. Examples: linen tape, craft paper tape.
- Adhesive residue: An accretion sitting on the surface or permeating the substrate fibers, applied overall or locally, which may be tacky, cracked or brittle and cause sticking, skinning, contraction, or staining. Eg: paste, glue, resin, wax, etc.

IV. CONCLUSION

Paper documents are the biggest source, which consist our maximum (ample) history, because they have a lot of information regarding our ancestor's habit and habitat, art and cultures, festivals and rituals etc. Besides it paper documents have more information of medicine, religion, agriculture and so on. But unfortunately all these information are being loss day by day due to deterioration of paper documents. Lack of knowledge regarding storage and display of paper documents, mishandling and using of low grade material for packing and transportation, faulty conservation work, etc. are the main reasons for the damaging of documents. Due to this a lot of problems arise in the paper objects. We should more study on the problems of paper documents and their causes and their solutions. If we will not save these collection as soon as, then we will lost our past memory in very short time. Preventive conservation is the best solution for the saving of these paper documents for a long time or future generation.

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