CHAPTER II

REVIEW OF LITERATURE

The review of literature of the study has been divided into the following sections:

2.1 Theoretical Review

2.2 Research Review

2.1 Theoretical Review

A carpet has been defined as a floor covering of thick woven material (54). The term has been derived from the Latin word carpere meaning 'to pluck'. Until the 19th Century the word was used for any type of cover made of heavy material. This wider meaning embraced all types of tapestry and cloth made of felt or pile or the ones that had been shuttle woven. Floor coverings of plaited rushes probably originated in the 5th and the 4th millennium B.C. but the earliest fragment of carpet was the Pazyrk rug.

In his book 'Oriental Carpets and Rugs' Formenton (24) has described the Pazyrk rug. The carpet, dating back to the 5th Century B.C., was found in one of the Scythian burial sites in Altai mountains, near the border of outer Mongolia. Measuring 2.03 x 1.82 m.,

the rug has been woven with great technical skill and has about 270 knots to 2.50 cms square. A splayed fork, most probably used by the Scythian women to beat the weft has also been found in another burial chamber. These discoveries have led to the belief that in a much more remote epoch than the 16th Century Imperial period, carpet making had gone through an earlier brilliant phase in which a very high level of technique and decorative values had been reached.

References to rugs made by Persian tribes have been made in the works by geographers as early as the 9th and the 10th Century (39) and various forms of bisat and farash-meaning carpet repeatedly occurred on the works of the Arab writers from the 8th Century onwards. The earliest forms of ornamentation consisted of simple, geometrical figures, bordered areas and large blocks of colour.

The earliest records of carpet weaving could be traced down to pictures that depict weavers at work in the rock cut tomb at Benihassan, Egypt, dating back to 2800 to 2600 B.C. (4). Antiquariams in the industrial arts have ventured to locate the period of their advent as approximately 5000 B.C. Egypt appeared to be the place where carpet weaving originated. From

there it entered Assyria and then Asia Minor and later Greece and other places. The Babylonians and the Assyrians were accomplished weavers of some kind of floor covering and it is believed that they acquired this knowledge from nomads and tribesmen of the neighbouring East. Another school of thought suggested that from the East the craft spread to Middle East, along the Mediteranean coast and finally came to England during the 17th Century. It was introduced in France in 1254 A.D., in Western Europe in 1453 and in India in the 16th Century.

According to Larson (41) the reign of Shah Abbas in Persia in the 16th and the 17th Century was the most important in the history of Oriental carpets. Large court factories were organised, obtaining outstanding artists who composed wonderful patterns with flowers and figures that were similar to the ones being composed today. From the end of the 19th Century the demand for Oriental rugs rose sharply, and the exports to other parts of the world shot up. In Turkey, a completely new rug manufacturing centre was organised, to produce rugs in sizes more suitable for contemporary use. Ushak, Eskisheerm, Sparta and Ghiordes came to be known as important centres of rugs. Centres were also

set up in Tabriz and Sultanabad. The new form of manufacture produced qualities, patterns and standard sizes suitable for European and American market.

Rug weaving in China, while not as ancient as in Western Asia, was at least a thousand year old (3). By the 15th Century and the 16th Century, some of the principal characteristics of Chinese rugs were well established and these were quite distinct from other rug styles. The patterns which were typically, though not invariably, in dark (indigo blue) on lighter grounds (tawny tans and golden yellows), strongly contrasted, were very simple: openwork geometrical patterns including stylised lotuses. The reserve, quiet spacing, luxurious pile and the glow of the tones in the earlier carpets, all have remained essential features of later weaving. In these Buddhist and Taoist symbols were often distributed, rather loosely, all over the field.

Pile carpets have been probably used in Tibet for at least the last nine hundred years (18). The word gdan has been fairly commonly used in Tibetan literature. The Bompo text gZi-brjid (33) composed probably in the 14th Century has mentioned gdan of various kinds in the text of religious arts and crafts. 'Single' or 'simple' gdan bearing designs of vajras,

swastika, lotuses, royal wheels and wish granting gems have been mentioned in it. 'Double' or 'complex' gdan with lattice work design in the central field, surrounded by fine coloured borders and gdan of silk or cotton piled up in three, five, seven or nine layers, suitable for royal rank, were also made in Tibet.

Tibet has been producing three types of carpets - woven, looped and knotted. Before the first world war all the raw materials used were produced at home. The warp, weft and the pile were made from homespun Tibetan wool and the dyestuffs were obtained from plants and minerals found in Tibet. Three distinct kinds of looms were used for carpet weaving. The vertical loom called thgacha or thag - khri was exclusively used for carpet weaving but occasionally horizontal frameloom, khri-thag and backstrap loom, pang-thop also served the purpose. The accessories used alongwith the vertical loom were axis rod, shed stick, heddle rod, beater-in, mallet, gauge rod, knife and scissors. Most of the sticks and rods were made of bamboo. A strip of plain weave of four to six weft yarns was woven before starting the pile. Knotting of the pile was done by casting the knots around the warps and a gauge rod. After finishing the knotting, the rod was beaten with a mallet and half

a weaving cycle was completed. The knots were then cut with a knife. The finishing operations included teaseling, shearing, contouring and knotting of the fringes. Traditionally the first three operations were carried out on the loom itself. The usual range of knots in Tibetan carpets was 30 to 80 knots to 2.50 cms square and the pile height was 6 to 12 mm. The most common shape was oblong, typically 139 to 170.80 cms long. The designs made in Tibetan carpets were lotus designs made of roundels of lotuses, floral lozenges, peony flowers, dragons, pheonix, bats, crossed dorjes, swastika, the key and the mountain and the cloud motifs. Blue, red, black, orange, yellow and green colours were popular. These carpets were mainly used as bed, floor covers as well as saddle and door carpets (18).

Tibetan looped carpets were woven on backstrap or horizontal looms which only 36 to 41 cms wide strips could be woven (18). The principal difference between knotted and looped carpets were - in finished looped carpets, each pile yarn passed down behind a warp thread instead of knotting; the pile yarn was looped only around odd or even yarns in a row and the loops of the carpet never overlapped each other whereas many a knots of the knotted carpets might overlap each other sideways.

For looping, the pile yarn was taken between each of the upper set of yarns and its neighbour and was slipped over the gauge rod, moving from left to right. Plain or twill was used for making the basic fabric. Simple designs such as one or more narrow stripes across each end or borders contrasting with main ground were used in looped carpets. Patterns in the field were composed of simple squares or straight lines of different colours. The number of loops per square inch was 15 to 30. Two or more strips of looped carpet were sewn together lengthwise to make a carpet or a bed spread.

Due to arrival of thousands of Tibetan settlers who brought with them their traditional weaving skills and design traditions, Nepal's carpet production has grown rapidly in the past two decades (53). Hand knotted carpets of Nepal have been characterised by aesthetic designs borrowed from Tibetan culture. The pile of these carpets was woven with soft handspun sheep wool partly produced in the Himalayan region of Nepal and partly from wool from Tibet. Knotting was done in Tibetan style and average knot density of Nepalese carpets was 7 knots per square centimeter. Continuous double knotting resulted in two piles in each row gave extremely dense and springy pile. Weighing about 4 kgs per square

meter, these were 1 to 1.5 cm thick. Most common size produced was .92 x 1.82 m but .61 x .92, 1.22 x 1.82, 1.82 x 2.74, 2.74 x 3.64 and 3.64 x 4.86 m, sizes were also manufactured. The pheonix, Buddhist knot, the dragon, the snow lion, coins, vase and the swastika were remarkable among the series of designs. Though manufacture of carpets and rugs was widely spread in the hilly areas, commercial production was limitedly concentrated in towns and villages where refugees had settled. Small, home-based enterprenuer as well as organised manufacturer were equally responsible for the supply of hand knotted carpets.

There seemed to be no documentary evidence to date the antiquity of Indian carpets (16). Excavations on Turkestan revealed evidence of merchandise of Indian origin, the most important being a tablet dated on the 9th year of King Jitroghavarsham. Some old articles were also enumerated in which mentions had been made of sheep wool weaving appliances as also 'Namdis'. This has been accepted as the earliest reference to what we now know as namda made from pressed wool. It has also been presumed that Pata-lika mentioned in Pali literature was a kind of carpet. In the Buddhist literature of the early Christian era, references have

been made to Kachilindika which has been described as a soft stuff. The recorded history of the Indian pile carpet however seemed to start in the 16th Century when Mughal Emperor Akbar brought some Persian carpet weavers to India and had set up the Royal Workshop in which they were commissioned to produce carpets equal to those of their own country. This has generally been taken as the birth of the Indian pile carpets. While Akbar introduced the art of pile carpets in silk and wool, the great tradition was continued by his successors. The best carpets have been produced during the reign of Akbar, Jahangir and Shahjahan. These carpets generally followed the designs of Kirman, Kashan, Ispahan, Herat etc. Once the Indian weavers picked up the craft they soon began to orient the product to their own environment and suitability of their own setting. Although basically Persian, certain changes crept in the designs.

The practice of durrie weaving in India has been dated back to the 5th Century B.C. (49). Man must have learnt this craft prior to his being ready to weave a pile rug. Durries having cotton warp and weft have been documented by an Italian traveller, Bracciolini (39). Discussing such durries Watt and Brown have

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written, "it would seem probable that the carpets of India prior to the Mohemmedan conquests belonged exclusively to these (durries) description" (79). Though durries were very popular floor coverings in India, these caught the international attention after the Great London Exhibition of 1851, in which a few Indian durries had been displayed (48, 79).

Watson (78) has classified the carpets and rugs manufactured in India into five categories. The first one, made entirely of cotton had a close, stiff texture and a smooth surface. Named as sattrangie, these were the most common variety and were made over the whole of the country. The patterns lacked variety and were usually modifications of blue and white stripes with occasional introduction of a figure. The warp of the second type of floor coverings was also cotton but the woof was of wool. These too were striped the same way as ordinary sattrangie. These were woven on a horizontal loom without treadles or reed and the warp was streched out the whole length and breadth of the piece. The woof was not thrown across with a shuttle but was passed through by several workmen who brought the threads together with a wooden comb. The narrowest piece required two men and eight to ten were employed when

the breadth was greater. The third kind was made of cotton but instead of presenting a plain surface of the last two, a short, thick set of cotton pile was worked into it. For weaving these the warp yarns were put vertically. The fourth group consisted of carpets and rugs in which the pile was wool. These carpets were well known for their texture and beauty of patterns. In the fifth and the last division silk carpets were placed in which the pile was made in that expensive material. Ellore, Masulipatnam, Warangal, Benaras, Mirzapur, Gorakhpur and Bokhara were well known for producing intricately patterned quality wool carpets.

In the carpet industry in India, the organised sector, decentralised sector and the rural sector ran complimentary to one another (6). The industry provided a wide spectrum of units ranging from composite mills to village level weavers. Essentially a small scale, cottage industry, efforts have been made to organise the sector and a few composite carpet units have been established. There were about ten thousand small scale factory type units distributed in Punjab, Haryana, Himachal, Jammu & Kashmir, Rajasthan, Uttar Pradesh, Andhra Pradesh and Kerala. The set up had been divided between two functionaries, manufacturers and exporters

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on one hand and the master weavers and the loom owners on the other hand. In factory type units the workers were paid on daily or production basis. The raw materials, looms and the designs were provided by the owners. In unorganised set up the weavers carried out the work on contract basis from their houses. Alongwith the medium and the low quality, high quality carpets were being woven. Superfine quality carpets were woven in Kashmir, lower fine, medium fine and fine quality in Amritsar, Agra, Jaipur, Gwalior, Juanpur and Mirzapur. Lower medium and lower fine quality were woven in Bhadohi. The designs used were Persian in nature; Kirman, Kashan, Herati, Ispahan, Faraghan, Gilget, Hamdan, Bokhara and Linch being the popular ones. The industry was export oriented. United States, Britain and West Germany were the largest buyers of Indian hand knotted carpets. Switzerland, Canada, Belgium, Bulgaria and Sweden were other promising buyers.

According to Gupta (31) wool from highland regions was used for making hand knotted carpets in ancient times. The yarn was hand-spun and vegetable dyes were used for dyeing. However, with the commercialisation of hand knotted carpets various wool blends have been tried for making these. Although hand-spun yarn was

the best for making carpets, yarn spun on the woollen and semi-worsted machines were most widely used. In India Magra, Chokla, Nali, Kekri, and Bewar varieties of wool from Rajasthan have been considered most suitable for carpets. As there has been a gradual decline in the quality and production of raw wool in the country, large scale import of wool from countries such as New Zealand had to be undertaken. Noted for its fibre soundness, good colour and freedom from vegetable matter contamination, this wool was well suited for blending with indigenous Indian wool. The blends ranged from 30 per cent New Zealand wool with 70 per cent Indian wool and vice versa. Best results have been known from 30 per cent New Zealand and 70 per cent Chokla wool. Chokla was most suitable for the purpose because of its resiliency, a requisite character in carpet wool.

Describing the raw materials used in the carpet industry Batra (6) has written that while spun yarns of cotton and other natural materials were used in warps and bindings, the major input in this was the wool yarn for pile surface. Mainly two varieties of yarn were used - hand-spun accounting for 30 per cent of the consumption and the mill spun accounting for

the rest. Mill spun yarn was generally spun wool yarn though a small amount of worsted and half worsted yarns were also used. These yarns were much heavier than the ones used for the apparel purpose. Units producing coarse and medium pile combinations utilised heavier, bulkier and springy yarns whereas lean, lusterous, silky and white yarns spun from better quality Indian wools or its blends with imported, non-medullated carpet wool was used for superfine carpets. Indigenous wools from Bikaner, Kekri, Joria, Bewar, Panipat and Fazilka had characteristics suitable for coarse to medium quality carpets. The requirement of the industry for making fine and superfine carpets was partly met with wools from Rajasthan and Kashmir and partly from import of New Zealand and South American wools.

Essentially produced as a floor covering, the manufacture of hand knotted carpets did not require any mechanical contrivance (80). Only three tools, churra - a heavy knife, kainchi - a pair of scissors, and punja - an iron comb were used for weaving hand knotted carpets. Upright vertical looms were used for the purpose and the warp yarns, always cotton, were mounted on the upper beam. The woven fabric was wrapped

on the lower beam. Woollen warp was used only for special carpets such as Bukhara. Hand or mill spun woollen yarn was used for making the pile though use of cotton or a mixture of cotton, jute and wool were not uncommon. The type of wool used for carpets varied greatly with the quality of carpets. Medium quality carpets were made from good grades of Bikaner, Fazilka and Joria wools whereas the best quality floor coverings were manufactured with lusterous Australian, New Zealand, South American cross breeds. Wool from Kulu, Tibet, Kandhar and Ladakh hills was used either as such or was blended with Bikaner, Fazilka or Joria wool. Acid and premetallised dyes were used to impart colour to the yarns. The colours used in carpet weaving ranged from palest pastel shades for French Savonneire to deep, rich reds, golds and blues of the Oriental rugs. The base fabric of the carpets was woven in plain weave with a row of knots tied to a pair of adjacent warps, lying between two rows of weft. A few variations to this arrangement have been evolved. These were charni utarni dam made in 2/2 warp rib, teen dam with three rows of weft between two adjacent rows of pile tufts, jut or double knot in which a knot was tied on the adjacent pair of warps. Bhadohi weavers had evolved another variation of jut. Known as dutapia, the

technique made use of alternate warp threads to tie the knot. The fineness of the carpets, judged from knots per 2.50 cms square might vary from 6 knots to 500 knots. With the use of silk warp and weft 3000 knots to 2.50 cms square have also been produced. The height of cut tufts of Indian pile carpets standing at right angles to the based fabric might lie between 3 mm in fine carpets to 12 mm in plain rugs. Though the best grades of carpets developed luster gradually through use, chemical wash was given to attain luster, a quality demanded by the consumers at the time of purchasing carpets. For this, very severe treatments with caustic soda and chloride of lime was given. Flexibility of design, colour and fineness were the features which would be helpful in fighting off any threat imposed by machine made carpets. Regular and sufficient supply of raw materials, dyes and chemicals, competent design services, stringent quality control measures, intelligent marketing analysis and provision of credit facilities to the weavers could lead to further development of the industry.

In her book 'Handicrafts of India', Chattopadhyay (17) has described the Indian hand knotted carpets in great detail. According to her Indian carpet weavers

cover a surprisingly wide range of carpets due to diverse demands of the foreign market. These include delicate Indo-Persian to the abstract Scandinavian; from the sturdy Central Asian to the quiet Abusson; from heavy Savonneric to the quaint Chinese. Indo-Persian carpets were woven with old Talim system in Kashmir and Amritsar. Popular designs in Kashmir carpets were the scenic or pictorial ones with finely drawn scrolling stems, leaves, giant flower heads and flowering trees. Integrated designs were wrought with combinations of little cartouches, attractive rosettes and palmettes. Kashmiri weavers specialised in making Bokhara carpets whereas Mauri was the speciality of Amritsar weavers.

Uttar Pradesh has the largest concentration of carpet weaving in the country (17). The main centres were Mirzapur, Bhadohi, Khamria, and about 500 villages in and around this area. The centres were mostly export oriented and in the absence of any traditional background they produced almost any design. Chinese emboss, Abusson and Savonneric patterns on pastel shades are the popular export items. The carpets of this region were mostly in medium quality with 60 knots to 2.50 cms square. Agra was one of the oldest carpet

centres of the Mughal days. Today it was a compact sized industry and did both, traditional as well as the new designs. Indo-Ispahan was done with long leaves and flowers. Weaving here was done in phera bolna system as the master weaver alone followed the design and kept calling out to the weavers the colours to be used for each knot. In Shahjehanpur both cotton and woollen carpets were made with 16 to 36 knots. The designs were based on the old Persian ones.

Jaipur was once renowned for its carpets having 400 to 600 knots per 2.50 cms square but now the concentration was on 16 to 36 knots (17). Indo-Heratic designs consisting of small angular motifs enclosing little rosettes were made. In some, medallions with corners were made. The Indo-Kirman had an ivory or cream field with floral sprays either in overall designs or with just a dainty floral centre. Carpets were also produced in Ajmer and Bikaner in Rajasthan.

The pile industry of Andhra Pradesh, centred in Elluru and Warangal seemed to be a direct descendent of the Persian carpet industry. The fine quality has now given way to the ordinary with 16 to 36 knots to 2.50 cms square. The central ground of the carpet here was called a khana and the border anchu. The designs

were mostly floral and geometrical. Hashim Khani was a flowery pattern with curvilinear leaves on either side, on a cream background. Thotti Khani was a big composition built around a flower pot. The dilli khani had a medallion in the centre depicting a boat and flowers done in palmette pattern (17).

Old designs based on Indo-Persian style were produced in Obra in Bihar earlier. Now a rough variety in the usual geometrical and floral patterns were made (17).

Panipat and Palampur were two new centres in the field of carpet weaving. The former rose as a result of the refugees starting new industries there and made plain carpets. In Palampur the designs were based on those of Kashmir and the same talim system was in vogue (17).

The Bhutias in the Himalayas make bed side carpets, duns and asnas to sit on. The designs used were either old alpana designs or Tibetan. Darjeeling and Kalimpong have Tibetan carpet weaving centres, making carpets with 40 knots to 2.50 cms square. Tibetan designs have a wide range with duk goh, the dragon standing still, being the most conspicuous one. Duk-thang-gyaja has a

dragon and a bird and the pema gyaja - lotus and bird. A special feature of these carpets was the V-shaped cut made all along the design to give relief to various parts of the design (17).

Describing the technique used for manufacturing carpets in the Himalayan region Dhamija (19) has written that the method of knotting of the pile of these carpets was quite different from one normally practised in other commercial centres in India. The technique was more like looping of threads with the use of a rod or a stick, which was placed horizontally and at right angles to the warp. The thread was looped around the warp threads and the rod. To start the work the thread was twisted against one warp thread and looped into the pointed edge of the rod. This was repeated once or twice and then the knotting started. For this the pile yarn was rolled on the little finger and held by the thumb and the index finger. Two warp threads were separated and the yarn was pushed in from the right hand side to the left, a part of the strand was held by the left hand's index finger and was pushed over the rod. The thread was pulled downwards and underneath the rod and the same procedure was repeated. After knotting had been completed a shot of 3 ply weft was thrown twice.

In Himachal Pradesh, Kinnuar has been noted for its fine weave (16). When the extra soft pashmina was separated from the coarse residue wool by sorting and sifting, the latter got spun into a yarn called sheli which was woven into coarse carpets called kharcha, chuktu and chugdan. When ordinary goat hair wool was mixed it resulted in a slight variation in texture and was woven mainly in black and white colours. Pangi in Chamba produced a carpet called thobi. Made from goat hair, it was woven on such a tiny loom that four to five pieces were stitched together to form a full carpet. Though woven in natural colours, by a clever arrangement of the black and white threads, a special design was made to emerge. These sometimes carried a trishul and a swastika design and also a strange eight pointed motif composed of a diamond and a concentric circle.

Manufacture of thobi has also been mentioned in a survey report of handicrafts of Chamba (22). Woven from goat hair or yak hair or both mixed together, the yarn might be dyed according to the required colour. Weaving was done on a loom fixed in the ground. Stripes varying from 15 to 22.5 cms width were woven. These were stitched together according to the required size. The superfluous threads were cut off with the help of

a knife. These were used as floor coverings and as mats. Pangi, Tissa and Brahmour blocks were known for thobi making.

By far the largest volume and varieties of floor coverings made in India were cotton durries or satrangies. These were made in a single colour or stripes in different colours or broken into rectilinear sections. These durries were woven all over the country in infinite varieties. Among the picturesque were the colourful durries of Navalgund, a small place in Dharwar district of Karnataka. Cotton durries having geometrical designs were made here. The outlines were made in delicate tracery with floral motifs in borders and an occasional bird or animal form (16).

The Bhawani durries of Coimbatore in Tamil Nadu were woven in cotton or silk. On a cotton base, cotton stripes or traditional designs were woven and on silk base in silk (16).

Among the durries of Madhya Pradesh, those of Jobat and Thibgaon deserve to be mentioned. Weaving in Jobat was simple, done on the pitlooms with punja (16).

Durries were produced on a wide scale in Warangal, in attractive shades, sometimes with contrasting borders

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or simple motifs woven into the body. They were also made extensively in and around Obra, Bihar (16).

Punjab was at one time famous for its durries. Bed and floor durries were made on a loom called adda on which three persons worked simultaneously (16, 17). These were made in two or multi-coloured stripes in Nakodar and Mani Majra. The most interesting and colourful were the punja durries made by women as a domestic vocation. Folk designs having bold, colourful figures were used for these.

Himachal, though essentially a wool region, also has cotton durries. They were usually plain, in red and blue but sometimes other colours were also used. Designs were also introduced by an arrangement of warp and weft threads in stripes. The expert weavers in Sirmuar area of Himachal used pitloom with two healds and the designs were produced by interlacing of weft with warp yarns. Different effects were obtained by using threads of varying thickness and colours (17).

Equally colourful though not as exotic was the namda (17). The namda could be just plain or with a beautifully ornamented background. These were prepared by spreading the wool evenly on a sack. It was then

moistened with chalk and rolled forward and backward with a large rolling pin till the wool was evenly felted. Coloured designs were formed with dyed wool which was used to embroider decorative designs or applique work; Kashmir namdas were famous and justly popular, having floral as well as geometrical designs. Rajasthan also produced namdas which were either embroidered or had printed surface (17).

Batra (7) reported under utilization of weaving capacity, high rate of taxes and unexpected hike in prices of carpet wool led to crisis and problems in carpet industry. Small and medium sized enterprenuers lacked capital to freely mass produce and were obliged to specialise in production by order from large firms. This limited the utilization of existing weaving capacity and ingenuity of the weavers. Another financial constraint was the lack of adequate assistance from financing agencies such as banks, financial corporations etc. Growth of high quality products in the industry was frequently jeopardised due to high rate of taxation of raw wool, yarn and finishing for improving the quality of carpets. High interest rates on loans for carpet industry had a negative effect on production and export of carpets in international market.

Unexpected hike in the indigenous wool was stated to have a spiral effect whereas higher rates of taxes and import duties on New Zealand carpet wool turned the product unprofitable and uncompetitive in the international market. To overcome these handicaps proper pricing of raw materials, together with updated spinning technology and improved quality of carpet yarn should be stressed. Proper representation to put forth its needs to government and formulation of more realistic policies for this sub-sector were the need of the hour.

2.2 Research Review

The research review of the study has been further divided into the following sub-sections:

- 2.2.1 Studies on Manufacture of Floor Coverings of India
- 2.2.2 Studies on Properties of Carpets
- 2.2.3 Studies on Finishes.

2.2.1 Studies on Manufacture of Floor Coverings of India

Nayyar (50) undertook a survey to study the structure of carpet industry in Bhadohi. The results showed that most of the units had made a fixed capital investment of one to five lakh rupees, but a few had

invested more than fifteen lakh rupees. The manufacturers employed permanent skilled workers as designers, dyers and for finishing the carpets. Most of the carpet production was carried out on the basis of orders received from manufacturers and exporters. Rugs, runners and druggets were manufactured in Persian, Caucasian and French Abusson designs. Tabriz, Hariz, Tabassum, Muaraya and Taj Mahal were the most popular designs made. Coarse and medium quality formed the bulk of the carpets produced. Mill spun white yarn of 6/6s, 6/8s and 12/20s was used as warp, the weft being dyed yarn of 7s, 15s, 25s, or 45s fineness. The carpets had about 12 mm thick pile made from 30s, 48s or 60s woollen yarn. Chokla and Magra wool of Rajasthan, Gujarat and Punjab alongwith imported New Zealand wool were used as pile yarns. The manufacturers supplied the raw materials and the designs to loom owners or weavers who weave the carpets at home. Only chemical finishing was carried out on the premises. Vertical looms of 1.52 to 3.04 m were used for making carpets. The accessories used alongwith were knife, scissors, punja and graduated gauge for taking measurements. Generally 3 to 5 weavers worked on one loom. After each row of knotting one or more weft threads were woven in. The knots were then beaten in with a punja. Balls of woollen yarn were tied above

the loom so that these hung within an easy reach of the weavers. The weavers were able to complete a 1.82 x 2.74 m carpet in 3 months. Average output of the weavers was 7000 to 8000 knots per day for which they were paid Rs.200/- to Rs.900/- per month, according to their work output. Carpets from Bhadohi were exported to America and West Germany. Main problems faced by the industry were shortage of quality yarn, high taxation and lack of transportation.

Virk (75) conducted a study on carpets, durries and khes of Punjab. She found that carpet weaving in the state was done in Amritsar, Hoshiarpur and Roopnagar districts. Vertical loom called khaddi was used for weaving carpets. Punja, knife and scissors were used as accessories. Unbleached and undyed yarn of 2 and 3 ply was used for warping. The pile was made of 2 ply, 3 ply, 4 ply, 6 ply or 8 ply Indian or imported wool. Cotton was purchased from Ludhiana, Amritsar, Nalagarh, Panipat and Chandigarh whereas wool was bought from Ludhiana, Amritsar, Bombay, Chandigarh, Nalagarh and Panipat or was imported from other countries. The sizes of the carpets were .61 x 1.22, .92 x 1.52, 1.82 x 2.74, 2.74 x 3.64 and 3.64 x 4.86 m with 3, 9 or 15 mm pile. Number of knots

per 2.50 cms square varied from 9 x 6, 10 x 10, 10 x 14, 11 x 19, 12 x 15 and 12 x 18. Turkish or Persian knot, either single or double, were used for making pile. Geometric, floral, leaf, tree and animal motifs or signs and symbols were used to make Persian or modified Persian designs. Chandchothai, Purmatan, Guldasta, Herati, Kashan and Tabriz were the popular designs. The colours used were red, blue, yellow, peacock blue, pink, brown, white, black, orange, light blue, purple and light green. Time taken for weaving one carpet ranged from 1 or 2 days to 4 - 6 months, depending on the size and the knots of the carpet and the number of weavers working on a loom. Though women were employed in many centres, weaving was mainly done by men. Price of the carpets varied from Rs.140/- to Rs.250/- per 30 cms square. Durrie weaving was done on horizontal pitloom and fly shuttle looms. A beater, wooden plank and a punja or reed were used alongwith. Desi Bengal cotton or thick machine spun cotton yarn of 2/6s, 5/10s, 3/6s or 6/6s was used as warp with the weft being made of 10s, 20s, 2/4s and 2/6s. Cotton was purchased from Garshankar, Nawanshahar, Ludhiana, Nakodar, Jagraon, Nabha, Dhuri, Barnala, Sangrur, Kaithal, Ambala and Bassi Pathan. Dyeing was done with direct or vat dyes. For pitlooms, warping was done in

the open whereas the fly shuttle loom was warped directly. Designs used were based on geometric patterns and the motifs used were flowers, leaves, animals, human figures and trees. Depending on the designs the durries were referred to as gulchaman, guddedar, borderdar, gulbahar, shera di durrie, sehayan di durrie, and bella wali durrie. Brown, dark blue, light blue, purple, white, light green, orange, red, yellow, green, peacock blue and maroon colours were used in durries. Standard sizes of the durrie was 120 x 250 cms and one durrie was completed in four hours to four weeks. Price of one bed durrie ranged from Rs.25/- to Rs.150/- and floor durries were sold for Rs.200/- to Rs.250/- per piece. Demand for durries was very high in the domestic market but alongwith the carpets, these were exported to America, Canada, United Kingdom, France, Australia and Scandinavian countries.

Wani (76) undertook a research to study the floor coverings manufactured in Kashmir. Her results showed that the carpets in the state were woven on a vertical loom, using punja, knife and scissors as accessories. Unbleached cotton yarn of 2 to 7 ply was used as warp. Pile was made of 2 or 3 ply wool or silk. Cotton was purchased from Amritsar, Ahmedabad and Ludhiana

whereas the wool was obtained from Amritsar, Ludhiana or Rajasthan. Local wool was used for making inferior quality carpets. Warping was first done on iron rods and was later transferred to the loom. Harness stick was used for shed formation. After every row of pile a shot of weft yarn was passed. Designers prepared the designs in coded talim which was chanted by the head weaver and followed by his coworkers during weaving. Tabriz, Arbedil, Kashan, Kirman, Tree of life, Theridar, Meenakhani, Joshgan, Hedyayki, Chandchotha, Neelam, geometrical and modified Persian designs were used in Kashmiri carpets. Depending upon the design, about sixteen colours were used for weaving. Some of these were red, green, blue, peacock blue, pink, copper, brown and badami. The pile was made with single or double Persian knots with the knot density varying from 12 x 12, 13 x 13, 14 x 14, 16 x 16, 18 x 18, 20 x 20 and 24 x 24 knots to a 2.50 cms square. The pile height varied from 6 to 12 mm. The finishing processes included clipping and washing. Men did warping and weaving whereas the women undertook only weaving. Boys and girls worked as their assistants. On an average men earned Rs.10/- to Rs.25/-, women Rs.8/- to Rs.10/-, boys Rs.4/- to Rs.9/- and girls Rs.4/- to Rs.9/- daily. Depending upon the number of knots to

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2.50 cms square the price of a 1.82 x 2.74 m carpet varied from Rs.7560/- to Rs.10800/-. Namdas in the state were manufactured in Srinagar and Chudur either in co-operative, private or government run centres. Felt was made only at two centres, the rest undertook only embroidery work. Local raw wool and cotton from Ludhiana, Ahmedabad and Amritsar was used for making felt. Cotton and wool were spread in layers on a reed mat which was rolled back and forth till the felt was ready. Before starting the embroidery, pattern maker traced the design. Using chain stitch a jalakdoz (embroiderer) did the embroidery with a hook needle. The work was known as Auri Koum. Natural flora and fauna motifs were used to make Theridar. Butakdar, Chinar leaf, Bulbuldar, Badamdar, Double Badami, Yamberzel, Chelvun, Larvun, Sumerkand, Guldar, Shikargah and Jannardar designs. Single or double ply wool of red, green, brown, pink, black and crimson colours were used on an off white background. Though made in many sizes .92 x 1.82, 1.22 x 1.82, and .92 x 1.52 m were the most common sizes. The thickness of the namdas was 6 to 12 mm. A 1.22 x 1.82 m namda was embroidered in 4 days. These were sold in the domestic market or were exported to America, West Germany, Australia, England, France and Arab countries.

Price of a namda depended upon its size and percentage of cotton in it. A hundred per cent wool namda of 1.22 x 1.82 m size was sold for Rs.153/- only.

To study the gradual development of the art of durrie weaving, its techniques, socio-economic status of the durrie weavers and its problems, Malhi (43) conducted a survey in different blocks of Ludhiana district. It was observed that the designs used in earlier times were simple, phattian and gut being popular motifs used for making durries. Contemporary motifs included a wide range of geometrical, floral, figured, numerical and word motifs. Home spun yarn was used which was dyed with direct dyes. In old times multi-coloured yarns dyed with natural dyes were used but now the colours were limited to 2 or 3. Earlier hand spun yarn was used for both the warp and the weft but now mill spun yarn of 8s to 10s was used as warp. Pit-loom used in olden days has been replaced by adda. The accessories used alongwith this were punja - a beater, panakh - a wooden plank, phatti - shed sticks and makpe - the treadles. Bed durries in 2.20 x 1.10 m, weighing 2½ to 3 kgs were made by using dovetail tapestry technique. The colour combinations used by the weavers were blue and white or brown and white. Durrie

weaving was mainly a seasonal occupation practised for only 2 to 4 months in a year. Daily input of the weavers varied from 5 to 6 hours a day to more than 10 hours a day. Time taken for making one durrie was 72 to 80 hours though complicated designs took as much as 224 hours. Majority of the weavers made 1 to 5 durries in a year but some weavers made as many as 25 to 30 durries per year. Durries were made for both domestic use as well as on order. The wages earned by weavers varied from Rs.20/- to Rs.35/- per durrie. Some of the common handicaps of the durrie weavers were low dye fastness, lack of designs and undesirable colour combinations.

2.2.2 Studies on Wear Characteristics of Carpets

Batra and Rawat (8) studied the appearance retention of commercial grade carpets. The results showed that the initial loss in thickness was very rapid which later stabilised to a steady ratio. Deformation in pile varied appreciably in accordance with the inherent properties of wool comprising the pile yarn. The impact of construction in resisting dynamic forces responsible for pile compression was negligible. Carpets having longer piles and finer yarns had lower resistance to compression due to dynamic loading. Differences in the pile weight and pile density did not show any consistent

effect on appearance retention.

A direct comparison of the compressibility characteristics of Jaisalmeri, Magra, Chokla and Nali wool carpets of similar pile heights revealed that Nali wool carpets were liable to compression to a lesser extent than other wools. Chokla was placed next to Nali and Jaisalmeri and Magra showed irregular trends. It was also suggested that for similar height and pile density combinations, compressibility had an indirect relationship to recovery. Chokla wool carpets retained their appearance better than other wools, These also showed minimum weight loss after 4000 abrasion cycles. Jaisalmeri wool was ranked next to Chokla and Magra occupied the third position. Rate of weight loss at different stages of abrasion revealed that Magra wool carpets suffered higher weight losses during abrasion which decreased subsequently. An opposite trend was observed in Jaisalmeri carpets suggesting that these could maintain their appearance for a longer time.(5).

Sudnik (71) studied the wear properties of woven and tufted carpets made from wool, nylon, viscose rayon and acrylic fibres and blends of these fibres. Tests were conducted through actual wear on carpets and through the use of laboratory instruments. The results

showed that the carpets made from nylon possessed maximum abrasion resistance. Furthermore introduction of nylon in the blend appeared to have a positive effect on the abrasion resistance of the carpets. A comparison of two types of tests showed that the results of WIRA Abrasion Tester usually confirmed to the rankings of the carpets in actual use.

Carnaby (14) had put forward a theory according to which the principal agents responsible for the loss of thickness might be frictional slippage effects which occur both within the yarn and between different yarns in both, the pile and the backing; the visco-elastic behaviour of the fibres, both in the pile and the backing and loss of pile by abrasion because of fatigue, cutting and breaking off of individual fibres and the shedding of unbound fibres.

Anderson and Robinson (2) examined the fibres in wool fabrics during abrasion and in worn garments with scanning electron microscope. The results showed that the most likely mechanism, the removal of cuticle, followed by fibrillation at various places along the fibre. Small sections of the fibre were then broken away and rupture occured at the fibrillated zones. Thus the loss in weight was not caused by the wearing

thin of the individual fibres but through formation and loss of short pieces of fibres.

Although maximum bending strains in compressed carpets occurred near the tufts, Quayle (60) has shown that the damage in worn carpets was invariably preferentially located near the top of tufts at the carpet surface. This observation applied to carpets made from various fibres. It therefore seemed that during the abrasion of pile carpets, short sections of fibre were continually being removed from the surface of the pile. This would imply that the loss in mass should be linearly related to the number of treads or deformation/ recovery cycles.

Postle et al (59) found that in the early stages of carpet wear, 500 or 1000 treads, the predominant mechanism causing changes in thickness was mainly flattening of pile but to a lesser extent also the backing. While flattening of the carpets was clearly dominant mechanism causing loss of thickness in the early stages of wear, the carpet soon settled down to a fibre packing density which remained constant. The extent of this early compression was a major factor in vitally important consumer issue of 'carpet newness retention'. However further long-term loss of thickness

was primarily the result of a reduction in the mass, while the density of the compacted carpet remained more or less constant.

Hearle and Lomas (35) have shown that the loss of fibre mass in the long term carpet wear was caused by production and loss of short fibres segments. These were created by the mechanism suggested by Anderson and Robinson (2).

2.2.3 Studies on Finishes

Using persulphate and peroxide - ferrous ion initiator systems Lohani et al (42) evolved a method whereby polyacrylonitrile was deposited on wool in a short time, in the presence of air. Persulphate altered the set and the super contraction of fabric samples to a greater extent than the peroxide - ferrous ion initiator system which had virtually no effect on these properties. Polymer deposited with persulphate was almost as effective in reducing the milling shrinkage as the other technique. The directional frictional effect was almost unaltered but the strength was reduced with persulphate treatment. Using a Broadhurst Lee Ring Wear Tester the abrasion resistance was also studied, but the results of the test had not been reported.

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Pavleth and Attila (58) studied grafting of wool through free radical formation on protein. Acrylic acid monomer was used as a finishing agent with 4,4 azo-bis-cyanopentanoic acid, t-butyl per-tetrahydrophthalic acid, succinic peroxide and t-butyl permaloic acid as catalysts. One set of swatches was prepared with the catalysts before applying the monomer whereas the second set was impregnated with the monomer before introducing the catalysts. Catalyst t-butyl per-tetrahydrophthalic acid gave the best grafting. The results showed that grafting led to reduction in area shrinkage, the amount of which depended upon the method used for polymerisation. Peroxide wool redox system gave shrink resistance in the grafted wool.

Krishnia (40) used different types of pretreatments before grafting wool with acrylic acid. Formic acid, polyethylene glycol, ammonium thiocynate, ethylene diamine and propanol were used as pretreatments before finishing these with Ahuracryl TX 50, an acrylic acid emulsion. The results showed that all the pretreatments except with ammonium thiocyanate and ethylene diamine were effective in increasing the tensile strength of the fabric. Maximum increase in tensile strength was observed with formic acid pretreatment. Irrespective of

the pretreatment used, all the samples showed good crease recovery.

The effect of DC-Corona and ferrous-ammonium sulphate pretreatments on grafting of methylmethacrylate on wool was studied by Bhalla and Nigam (9). The results showed that with an increase in concentration of methylmathacrylate, the percentage of polymer deposited on wool increased with ferrous ammonium sulphate initiator. Corona pretreated wool grafts showed slight relaxation shrinkage. In general the tensile strength of the wool increased both with increase in concentration and increase in grafting time. The increase in strength was more for ferrous-ammonium sulphate pretreated fabrics whereas improvements on percentage elongation at break was more for DC Corona pretreated wool.

Modi (47) studied the effect of acrylamide finishes on abrasive wear properties of cotton, polyester and cotton-polyester blends. Chloroacetic acid - hydrogen peroxide, sodium thiosulphate - ammonium persulphate and glyoxal - hydrogen peroxide initiator systems were used for crosslinking. The results showed that the finishing treatments protected all the fabrics against flat, impact and rotary abrasion. The lubricating effect of the finish alongwith increased flexibility were thought

to be the reasons for the increased resistance. Tensile strength and stiffness of the treated fabrics increased but there was a marked decrease in elongation, tear strength and wrinkle recovery.

Haycook (34) and Warfield (78) confirmed the theory that when the abradant pressure was low or when the abrasion was predominantly frictional (mild abrasion conditions), there might be a decrease in abrasion resistance of a resin treated fabric. Resin finishing of cotton reduced the tendency of its fibres to be teased to the fabric surface and there was greater loss in weight of the abraded, treated fabric. But these fabrics retained a greater percentage of their original breaking strength after abrasion. Both these researchers concluded that resin finished fabrics had better retention of fibres within the yarn structure, contributing to greater inter fibre friction and therefore a higher fabric breaking strength, although the fracture and loss of fibres fragments was greater for these fabrics.

An investigation has been reported in which New Zealand wool was polymerised with different solutions of polyacrylonitrile and soft polyacrylate (66). These were spun into worsted carpet yarns and tufted carpets with varied pile densities, pile weights and pile heights

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were prepared from these. Floor trials of the carpets to evaluate the role of polymer showed that these carpets soiled more than the control samples. Polyacrylonitrile reduced the wear life rather than increase it. More the addition of polymer, greater was the reduction in wear life. There was no significant change in the wear life with the softer polymethylacrylic acid polymer. The treatment also did not show any increase in the strength when an effort was made to make the fibres more springy through polyacrylonitrile treatment.

Wolfram and Menkart (81) investigated the properties of carpets made from yarn treated with acrylonitrile, methacrylic acid and methylacrylamide. The treatment improved sleezy and limp carpet wools. The investigation showed that the appearance retention of the carpets after 80000 passes derived considerable benefit from the presence of internally deposited polymer. In the early stages of wear the most important factor seemed to be the polymer add on; larger the deposition better the appearance retention for all the three species of polymers. Later stages of wear showed that polymethyl-acrylic acid containing materials deteriorated rapidly. Polymer treated carpets, specially the ones containing

polyacrylonitrile soiled distinctively less. The internal deposition of the polymer markedly reduced the tendency to felt, specially in loop pile carpets.

Felderman and Leeder (23) conducted experiments to study the effect of polar organic solvents on abrasion resistance of wool fabrics. Lipid dissolving solvents such as n-propanol, chloroform, methanol, acetic acid and formic acid were used as solvents. All the samples gave an increase in Martindale abrasion values and undiluted solvents showed better results than the water solvent mixtures except n-propanol. A comparison of the method of application of finish showed that the immersion of samples resulted in better abrasion resistance than the pad batch method. However, the treatment had very little effect on Flex abrasion of wool. Formic acid and n-propanol gave greater improvement in Flex abrasion.

Simpson (65) reported grafting of acrylate monomers within wool, initiated by copper (II) complexes formed through complexation of bis (acetyl acetonate), copper (II) with trichloro-acetate. Depending upon the method of initiator impregnation, the polymer grafted was either deposited just below the surface of the fibres, or was uniformly distributed throughout the fibre.

The results showed that soft polyacrylates deposited just below the surface of wool had significantly reduced the abrasion resistance and pilling of wool. It was noted that the introduction of cross linking co-monomers did not confer any improvement in these properties.

Hoechest and Schatner (38) evolved a process for improving end use properties of tufted carpets. The method comprised of mixing the dispersion or latexes for the precoat or the second coat with a flouro-surfactant. The surfactant was mixed with the latex used in the primary or the secondary backing. This improved the peeling resistance of secondary backing and anchorage of pile yarns.