Alberta
INFRASTRUCTURE

TECHNICAL BULLETIN

STANDARD OFFICE CARPET

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INTRODUCTION

This Technical Bulletin touches on some aspects of standard office carpet manufacture, construction and performance that have been found relevant in the context of dealing with installation and performance issues during the preparation of master specifications for carpet. It is hoped this information will be useful to architects, interior designers and specifiers of carpet generally. Sources for additional information about carpet manufacture, components, test methods and installation and maintenance are listed at the end of this Bulletin.

Glued-down broadloom carpet is currently the floor finish preferred by Alberta Infrastructure (INFRAS) for general-purpose office space because of comfort, aesthetic and acoustic qualities and relatively low maintenance cost in comparison to hard surface flooring. Installed cost can be comparable to other resilient floor finishes.

In addition to the above considerations, carpet selection should be made with due regard to performance over the expected product life cycle. Otherwise, because of the great variation in performance that can be found between carpets that appear to be similar, designers and specifiers may inadvertently specify product that results in unnecessary additional cost and the inconvenience of premature carpet replacement.

PRODUCT LIFE CYCLE

Until relatively recently, carpet replacement in Alberta government offices could be expected as soon as 7 years after installation. Until only a few years ago, the main reasons for replacing carpet were deteriorated appearance (primarily soiling, staining, colour fading and loss of texture) and safety concerns associated with delamination and ravelling at seams. Delamination appears to be the limiting factor at the moment, followed by deteriorated appearance. Current expectations are for a product life cycle of 10 years.

While product quality, not necessarily directly proportional to cost, is a major contributor to durability, carpet maintenance remains a significant factor affecting the durability of carpet.

CARPET SPECIFICATIONS

INFRAS uses CAN/CGSB 4.129 – Carpet for Commercial Use, as a starting point for developing carpet quality requirements. This Canadian national standard, as the product of a consensus process between representatives of producers, users and a general interest category, does not address all the relevant requirements identified by INFRAS. In addition to referencing this standard, INFRAS has added and upgraded some prescriptive and performance requirements.

The current INFRAS master specification for carpet was implemented in 1994, after extensive consultation with stakeholders. It represents a conscious effort to balance aesthetics, performance and cost.
To address some problems encountered during the carpet procurement process, this specification, emphasizing performance requirements, soon became the basis for prequalifying products for general purpose office space and for a seniors lodge upgrading program. These products are specified in Basic Master Specification Section 09680B – Infrastructure Standard Office

Carpet and Seniors Lodge Master Specification Section 09685SL - Carpet. These master specifications can be downloaded from the INFRAS Technical Resource Centre Website @ http://www.infras.gov.ab.ca/Content/doctype486/Production/09680b.doc

COMPONENTS

Carpet, both broadloom and modular, generally consists of the following components:

- Face Fibre
- Primary Backing
- Backing Laminate or, if no secondary fabric backing, a unitary backing or a pre-manufactured backing (typically a dense plastic or rubber foam) laminated to the greige carpet (yarn only tufted into primary backing, ready for the next step in manufacture).
- Secondary Fabric Backing (if applicable)

Pile Weight

Nylon is a hygroscopic material, that is, it readily absorbs atmospheric moisture. Published pile weight (per unit area) includes yarn above and below primary backing and is usually measured under controlled conditions at the greige stage of manufacture, before the application of additional backings. Pile weight is subsequently reduced up to 35 g/m^2 (1 oz/yd^2) after carpet is heated and stretched during manufacture. A 35 g/m^2 tolerance should be allowed because of the test method used to measure pile weight of finished carpet. Consequently, the finished pile weight of loop carpet can, if tested, be as much as 70 g/m^2 (2 oz/yd^2) lower than the published weight. In the case of cut pile and combinations of loop and shear, additional pile weight is lost during the shearing process.

In all tufted carpet, some of the face yarn ends up concealed below the primary backing. Straight stitching places about 5%-10% of face fibre below the primary backing, whereas, depending on tufting equipment and the type of patterning, cross stitching results 15%-30% of the pile weight being buried under the primary backing. Comfort and acoustical properties may be affected proportionately.

Face Fibre

A variety of synthetic fibres are suitable for standard office carpet. The most common synthetic fibre materials are nylon and olefin.

Carpet with olefin fibre has become readily available for the residential market in recent years as it costs less than nylon, resists staining well and does not generate static electricity like nylon does. It is not, however, as resilient as nylon.

Nylon, because of cost, resilience, dyeability and durability, is the preferred fibre material for typical INFRAS office applications. Two types of nylon are used to make nylon fibre: type 6 and type 6,6. Both are capable of producing acceptable carpet.

In North America, nylon resin manufacturers are the primary extruders of nylon carpet fibre. Honeywell and Allied Fibre extrude nylon 6 fibre. Invista and Solutia (formerly the fibre divisions of Duponts and Monsanto, respectively) extrude nylon 6,6 fibre. In addition, several carpet manufac-

turers have developed facilities to extrude their own carpet fibre using nylon 6 resin.

Carpet fibre is available in a variety of cross-sectional shapes, in order of increasing soil-hiding ability, from round, delta, variations of trilobal, and square and polygonal shapes containing multiple hollow cores. Fibre cross-section also affects fibre structural properties, efficient use of nylon material, soil-releasing properties and its feel or “hand”.

Synthetic carpet fibre is made as bulk continuous filament (BCF) and as staple fibre. BCF is used for both looped and cut pile carpets. Staple fibres are spun into staple yarns for cut pile carpets only. Staple yarn can be susceptible to fuzzing and pilling.

Primary Backing

Primary backing for tufted carpet is normally a pre-formed, tear-resistant woven or non-woven polypropylene fabric into which yarn is stitched or tufted. In addition to providing a structure into which the yarns can be fixed and to which secondary backings can be applied, primary backing contributes to the dimensional stability of finished carpet.

Backing Laminate

Backing laminate typically consists of a mixture of mineral filler and a styrene butadiene rubber (SBR) latex polymer. It is applied in heated liquid form to the back of greige carpet (the carpet is upside down at this stage) and just prior to addition of the secondary fabric backing.

If a backing laminate does not adequately encapsulate yarn fibres, the face yarn may exhibit "bearding" or fuzzing and with time will develop poor overall surface appearance. Some manufacturers apply a separate liquid pre-coating that better penetrates yarn to improve fibre encapsulation before applying a back coating. The appearance retention test method should identify inadequate fibre encapsulation.

Quality, quantity and adhesive application method affect fibre encapsulation, tuft bind, delamination strength between primary and secondary backings, carpet bulk and stiffness and dimensional stability.

In the past, some latex-based backing laminate has been found to crystallize as early as five years after installation, resulting in premature delamination. “No-VOC”, soft-set type SBR latex adhesives now available may not crystallize as quickly. The downside to this is that carpet may become more difficult to remove over the same period of time.

Moisture degrades SBR latex laminates, so carpet with latex based laminates should not be subjected to frequent and extensive exposure to moisture. To improve carpet’s moisture resistance, increase tuft bind and reduce delamination, some manufacturers can apply PVC or polyurethane based backing laminates.

Conductive materials can be added to backing laminate to provide static control.

Secondary Fabric Backing

Secondary fabric backings are typically a synthetic woven or non-woven fabric, laminated to the primary backing. Secondary fabric backings add dimensional stability to

the carpet, improved bonding to substrates and facilitate carpet removal.

Unitary Backings

Unitary backings combine the functions of backing laminate and secondary fabric backing, eliminating the possibility of delamination, and generally at lower cost. They are typically applied as liquid polymers – polyurethane, SBR latex, or PVC - to the back of greige carpet.

During installation, unitary backed carpets may be more prone to dimensional changes related to adhesive moisture absorption. This dimensional instability has to be taken into account by applicators to prevent bubbling of the carpet and opening seams. Unitary backed carpet tends to exhibit higher tuft bind because of the type of adhesives used. Still, yarn ravelling at seams and at other locations have been observed with this type of carpet.

Because of its construction, unitary backed carpet cannot delaminate, but it can and does “delaminate” from the substrate it is adhered to. The texture of the backing usually requires that different trowels be used to apply a greater quantity of a good quality adhesive developing high bond strength quickly.

Removing unitary backed carpet can be considerably more difficult due to the amount and quality of adhesive required during installation.

Pre-manufactured Backings

Carpets with premanufactured backing, because of weight and stiffness, is typically limited to a 1.8 m width, half the width of conventional broadloom, and to modular product, also known as carpet tile.

These backings are available in various synthetic formulations (usually PVC or polyurethane or other proprietary compositions), densities and thicknesses to suit different flooring requirements. Carpet with dense backing is commonly specified for health care facilities, where moisture impermeability is important for reasons of hygiene and a high density backing facilitates rolling traffic. Proper seam and perimeter sealing become critical for proper hygiene.

PILE CONSTRUCTION

Commercial carpet yarn is stitched, or tufted, by needle bars pushing yarn through primary backing. The distance between the needles is the gauge; the distance between the needle bars tufting into the primary backing is the pitch. Other less common methods of pile construction include weaving, needle punching, felting, knitting and fusion bonding. The face fibre of modular carpet used to be fusion bonded to backing but is now more commonly available in standard tufted construction laminated to a pre-manufactured backing.

Tufted yarn can be either straight-stitched or cross-stitched. Cross-stitching almost eliminates zippering and raveling and presents more patterning and texturing options, but generally buries more yarn under the primary backing.

Woven nylon carpet is sometimes considered for office applications because it eliminates concerns about tuft bind, delamination and dimensional instability and provides many pattern and texture options. Being more flexible than tufted carpet, woven carpet also offers better pattern edge matching capability. Woven carpet is classified into three types: Axminster, Wilton/Velvet and Kara-Loc®.

DYEING METHODS

There are two basic methods used to colour carpet fibre: dyeing before carpet is manufactured (pre-dyeing) and dyeing finished carpet (post-dyeing). Carpet manufacturers use these methods either singly or in combination.

PRE-DYEING

Solution Dyeing

Pigment is introduced during the fibre extrusion process. Solution dyeing can provide the largest dye lots, the most uniform carpet lot colour and, depending on pigment quality, can provide the best colour retention against aggressive cleaning agents, traffic and ultra-violet light. Chroma may be less saturated than fibre dyed after extrusion, i.e. colours may be weaker or carpet may have less colour “pop" than yarn-dyeing or post-dyed fibre.

Yarn Dyeing

A variety of dyeing methods fall into this category. Some of the more common methods are as follows:

Stock Dyeing

Loose staple fibre is dyed prior to spinning into yarn. Stock dyeing allows brighter colours and patterns, while providing satisfactory control over side-to-side shading variation.

Space Dyeing:

In this method, also known as “knit-deknit”, dye is applied in a colour sequence on pre-knitted yarn "socks", to be subsequently unraveled and processed into carpet. Space dyeing provides yarn in variegated colours to produce a multi-coloured, blended carpet colour pattern, somewhat reminiscent of impressionist pointillist painting technique.

Skein Dyeing

Dyeing skeins (large, loose reels) of yarn. This is a seldom used dye method.

POST-DYEING

Piece Dyeing

Dyeing by immersing tufted carpet in a dye bath to produce a solid colour, or multiple colours if yarns with differing dye affinities are used. Piece dyeing offers quicker delivery, more flexibility in colours and patterns, but less control of side-to-side shading variation in dye lots. Some carpet manufacturers piece-dye carpet that has already been solution dyed or space dyed.

Continuous Dyeing

This is a continuous feed of finished carpet through a dye bath, resulting in larger dye lots and less side-to-side shading variation than piece dyeing can provide.

Printing and Dye Injection

These are basically a variation of piece dyeing in that dyeing is applied to car-

pet, typically cut pile. This dye method provides the greatest custom patterning possibilities in tufted carpet, approaching that of woven carpet. Dye may or may not penetrate the full depth of the face fibre.

DYE LOT SIZE

Dye lot size may be concerns for large open areas, e.g., large lobbies, open plan offices, airport terminals and convention centres. Advancements in technology suggest that specifiers contact manufacturers to confirm dye lot sizes. Maximum dye lot size varies with dye method, approximately as follows:

Solution: 4,000-40,000 m^2.
Space: 4200 m^2 (one manufacturer claims 16,700 m^2).
Stock: 420 m^2.
Piece: 420-1420 m^2, depending on manufacturer and process.

Piece dyeing will be the most likely method used if dyeing method and dye lot size are not specified.

PERFORMANCE

The number of ways a carpet can fail has resulted in the development of various performance attributes. Most of these are discussed in the following articles. Test results for all except appearance retention are often available from the manufacturer and can help in product selection.

Tuft Bind

Tuft bind affects resistance to yarn zippering or raveling. This is critical for straight-stitched, and to a lesser extent, cross-stitched loop carpet. It affects tuft pull-out in cut pile carpet.

Tuft bind is normally reported as an average of tests performed on carpet sampled near the sides and middle of a roll. The industry norm for carpet using SBR latex backing laminate is around 53 N (12 lb). A number of Canadian carpet manufacturers offer 67 N (15 lb.) average tuft bind as a standard for some running lines. At carpet quantities over 1000 m^2, all Canadian manufacturers should be able to provide the higher quality latex backing laminate required to achieve higher tuft bind, at little additional cost. U.S. mills tend to provide a 53 N (12 lb) tuft bind.

Where relatively frequent wetting is anticipated, another type of backing laminate polymer may be required to maintain the desired tuft bind. In such situations, specify minimum 65 N tuft bind, both dry and after 2 hours immersion in water to ISO 2551-1981(E). Consult with manufacturers about limiting tuft bind degradation after immersion.

Delamination Strength

This property is important for carpets with secondary backing fabrics that are subjected to high rolling and twisting traffic, in other words, for the typical rolling office chair. Laminating compound quality and quantity affects delamination strength and durability in use. Most warranties against delamination are voided when carpet is installed when pads are not used under rolling office chairs. By definition, delamination strength does not apply to unitary backed carpet.

Reliance on specifying a high delamination strength may be misplaced, as standard latex laminated carpet installed in areas of high rolling and twisting traffic, passing requirements considerably more stringent than CGSB 4.129, has been observed to delaminate within 7 years after installation. This suggests a deficiency in the testing methodology.

The only way to avoid delamination entirely is to specify woven carpet or carpet with a unitary backing or a premanufactured backing.

Colourfastness

This attribute measures the resistance of carpet fibre against colour change caused by light, wet cleaning and crocking (a specific rubbing procedure). Normally the CGSB requirement of L5 (40AFU) suffices. For long daily direct sunlight exposures, consider specifying minimum L7 (169AFU) rating for colourfastness to light. Only solution dyed fibres with good quality pigments are likely to meet an L7 rating. AFU means Actual Fading Units.

Appearance Retention

This attribute, perhaps more than all others, simulates a carpet's ability to retain its appearance when subjected to traffic.

The laboratory test methods have been developed to provide a basis for measuring appearance retention on a comparative basis only. Because of the number of variables affecting carpet appearance retention, these methods cannot be expected to offer a direct correlation to performance in use.

Appearance retention is laboratory tested using the Hexapod Drum, Vettermann Drum or Tetrapod Drum. A ball with multiple "feet" tumbles over the pile surface of a carpet specimen lining the inside of a rotating drum. Trained evaluators assign an appearance rating from 5 to 1, based on observed changes to overall yarn texture and fibre structure, in comparison to CRI standard reference photographs as outlined in ISO Technical Report 9405. The higher the rating, the better the performance. ISO TR 10361, in contrast to the U.S. Carpet and Rug Institute's evaluation procedure, also assesses perceived colour change.

Round robin trials indicate that there can be substantial variation in ratings between and within labs that do the drum procedure and evaluate the results. This variation is minimized when using testing laboratories accredited to perform the test and evaluate the results. Laboratories in the U.S. are accredited under the National Voluntary Laboratory Accreditation Program (NVLAP) to perform the drum procedures but not to rate the samples. To date in North America only BodyCote/Ortech in Mississauga, Ontario is accredited (by the Standards Council of Canada) to evaluate samples subjected to the drum procedures. All aspects of appearance testing should be controlled and performed by the same accredited testing agency.

Stain Resistance

Carpet manufacturers use AATCC (American Association of Textile Chemists and Colorists) Test Method 175 to test for resistance to staining by acidic food colours. It is not a test designed to establish a carpet's

resistance to all of the stains it can be subjected to. Stain resistance treatments, typically stain-blocker dyes and/or topically applied fluorocarbons, are mainly provided for the residential market. AATCC Test Method 189 is used to confirm the presence of fluorocarbon treatment. Applied at sufficiently high temperature over an adequate time period, these topical treatments can provide a more durable protection against staining that will not be as quickly removed by carpet cleaning methods.

Static Propensity

Nylon carpet has a propensity to generate static electrical charge in building occupants walking on it. The dissipation of this charge on contact with building components, furniture and equipment can be a shock for some people and can damage sensitive electrical equipment lacking suitable anti-static protection. Nylon carpet therefore requires anti-static provisions. Often an anti-static solution is topically applied. A more permanent “solution” is to embed carbon fibres into the yarn or carpet fibres.

Standard commercial carpet will typically meet or exceed a 3 kV static propensity, when tested to AATCC 134. This threshold is considered suitable for personal computers and typical office equipment. Residential carpet is generally made to 5 KV. Each value is the generally accepted threshold of human discomfort in their context.

Relative humidities lower than 20%, cleanliness of carpet, shoe sole material and an individual’s walking style can all generate higher voltages.

For some situations not typical in offices, such as for unusually sensitive electronic equipment, specify attributes and values recommended by equipment manufacturers for the specific application. Considering the relatively small number of products capable of meeting more stringent requirements, the proprietary method of specifying may be advisable in such cases.

Flame Spread and Smoke Development

Carpet will not meet the flame spread/smoke developed classification typically required by building codes for finishes in exits. Otherwise, except for certain locations in "*high buildings*", the Alberta Building Code 1990 does not restrict flame spread and smoke development of floor finishes. Designers should verify code requirements before specifying carpet in exits and access to exits and for surfaces other than floors.

Performance Verification

Laboratory carpet testing is recommended for projects with carpet quantities exceeding 3000 m^2 and on a random basis for projects with smaller quantities. Carpet testing should be planned and budgeted for. As a minimum, carpets should be tested for appearance retention, colourfastness to light, cleaning and crocking, tuft bind, delamination strength and electrostatic propensity. Testing costs may be obtained from BODYCOTE/ORTECH in Mississauga, ON, tel: (905) 822-4111, fax: (905) 823-1446.

PATTERNED CARPET DEFECTS

Consult with manufacturers about tolerances to expect in relation to patterned carpet defects. Depending on the flexibility of the carpet and size and shape of pattern,

experienced installers can accommodate defects that are within industry tolerances.

Bow
Bending of carpet across its width.

Bias or Skew
Out of squareness of pattern across width and along length of carpet.

Repeat Variation
Also known as pattern run-off, this is variation in the size of the repeated pattern.

Trueness of Edge
Bending of patterned carpet along its length.

WARRANTIES
Manufacturers typically issue product warranties. Experience and the wording of standard warranties suggest that it would be better to rely on enforcement of a good specification.

Purchasers are cautioned to read warranties carefully and understand the following:

- The Canadian Carpet Institute states in their Installation Manual, that about half of carpet problems discovered after installation can be attributed to insufficient adhesive. Ensure installers use the right trowels and replace them before the "teeth" wear more than 15%.
- Warranties are subject to the installation and subsequent maintenance conforming to the carpet manufacturer's recommendations. The onus is generally on the purchaser to satisfy the manufacturer that both of these conditions have been met.
- About wear warranties: nylon fibre is a very tough material that does not wear appreciably over the normal life of a carpet. Carpets will become aesthetically unacceptable or fail in other respects before wearing out.
- Tuft bind and ravelling are mainly a concern with straight-stitched carpet; not with cross-stitched carpets. Most patterned commercial carpet is cross-stitched. If a tuft does come loose, it's not likely to pull out in a length sufficient to pose a safety hazard.
- Warranties against ravelling are subject to the correct application of seam sealer at carpet seams. Unfortunately, this installation requirement is seldom met, or enforced.
- Warranties against delamination of standard laminated commercial carpet usually require use of carpet pads under rolling chairs castors and do not apply where the carpet will be exposed to heavy rolling traffic or to carpet installed on stairs.
- Delamination of unitary backed carpets is a non-issue. This type of carpet can, however, delaminate from its substrate.

END OF TECHNICAL BULLETIN

Additional Sources:

CR 104 – Standard for Installation Specification for Commercial Carpet, Carpet and Rug Institute, http://www.carpet-rug.com/pdf_word_docs/104.pdf

Technical Manual of the American Association of Textile Chemists and Colorists, P.O. Box 12215 Research Triange Park, NC 27709, USA, Tel: (919) 549 8141; Fax: (919) 549 8933, http://www.aatcc.org/

IICRC S100, Standard and Reference Guide for Professional Carpet Cleaning. Institute of Inspection, Cleaning and Restoration Certification (IICRC) http://www.iicrc.org/

End of Bulletin