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BUREAU OF INDIAN STANDARDS

Draft Indian Standard

CODE OF PRACTICE FOR THE APPLICATION OF ADHESIVES IN FOOTWEAR INDUSTRY

(*First Revision* of IS 10815**)**

(ICS 83.180)

Plastics Sectional Committee, PCD 12

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FOREWORD

(Formal clauses to be added later)

This standard is originally published in 1984. This revision has been undertaken to update the cross-referred standards and inclusion of other types of sole like PU Soling, PVC Soling, etc.

Several adhesive formulations based on different materials exist in market. In footwear manufacture natural rubber solution and adhesives based on polychloroprene, polyurethane, nitrocellulose (pyroxylin) and natural rubber latex are extensively used in cementing and pasting operations. Of these, polychloroprene based adhesives are used widely.

To obtain good bond strength, preparation of the surface and proper application of the adhesives are as important as the adhesive formulation. This standard lays down guidelines for footwear manufacturers for proper handling and application of adhesives.

1 SCOPE

1.1 This standard lays down guidelines for application of adhesives in the footwear industry.

1.2 This standard does not cover the specification of the material.

2 REFERENCES

2.1 The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS	TITLE
2050 : 1991	Glossary of terms & elating to footwear (*first revision*)
8085 (Part 1) : 1986	Methods of test for footwear: Part 1 dimensions, fitting, adhesion test, peel test, heat resistance test and ageing test (*first revision*)

3 TERMINOLOGY

3.1 For the purpose of this standard, definitions given in IS 2050 shall apply.

4 APPLICATION OF ADHESIVE

4.1 Preparation of Surface to be Bonded — The surface of the material to be bonded shall be free from extraneous matter which might adversely affect the bond strength.

4.1.1 *Upper Leather* — With all upper leathers the grain layer shall be completely removed. This implies that not only the surface should be broken but it is necessary to get down to the strong fibers beneath the grain layer also.

4.1.1.1 With full chrome upper leather the correctly roughened surface (*see* Note) should present a coarse nap with no trace of the grain layer of finish remaining. The roughened surface should be the characteristic green/blue chrome colour except, of course, where the dyestuff has penetrated deeply into the leather. 'Furrow' in the surface generally indicate insufficient roughening.

NOTE — The leather should be roughened in a direction parallel to the subsequent direction of peeling or bond separation.

4.1.1.2 Certain semi-chrome leathers and most vegetable tanned leathers have a grain layer of thickness greater than full chrome leathers. Unless the grain is roughened away, not only will the adhesive have difficulty in penetrating (owing to the closer fiber weave there), but the weaker fibers of the grain, or possibly the weak stratum between the grain and corium layers, will cause the bond to break down relatively low loads. It is thus extremely important to remove all this grain layer, even though the leather is apparently being weakened. Semi-chrome, chrome retanned and vegetable tanned leathers are more difficult to stick even when the grain has satisfactorily been removed. With suedes, it is not normally essential to rough but in some cases a light roughening is advantageous mainly to remove dust.

4.1.2 *Sole Leather* — With sole leather (and insole leather) while adhesive lasting or rib attaching, it is necessary to ensure that all the loose flesh fibers are removed. In firmer or horny leathers loose fibers may not be present but in such cases it is necessary to break up the leather surface into a coarse nap. This permits the adhesive to penetrate and provide greater surface area for adhesion.

4.1.3 *Rubber Soling* — With rubbers (microcellular, resin composition and translucent or gristle) used for outer soles, middle-soles and heels, the surface 'skin' of rubber has to be removed. This 'skin' may contain ingredients that have migrated from the bulk of the rubber, as well as dirt and grease picked up by handling, etc. A good bond may not be possible unless this is removed and the rubber surface is roughened to increase the surface area. Ideally, the removal of this skin should take place shortly before the adhesive is to be applied.

4.1.4 *PU Soling* — PU soles should be suitably cleaned with solvent based cleaner . After that it should be chemically treated with solvent-based primer prior to application of adhesive.

4.1.5 *PVC Soling* — PVC soles should be suitably cleaned with solvent-based cleaner to remove Plasticizer, dirt and grease prior to the application of adhesive.

4.1.6 *EVA / Pylon Soling* — EVA soles should be suitably cleaned with solvent based cleaner. After that it should be chemically treated with solvent-based primer prior to application of adhesive.

4.1.7 *TPR Soling* — TPR soles should be suitably cleaned with solvent based cleaner . After that it should be chemically treated with solvent based primer prior to application of Adhesive.

4.1.8 *Plastics Upper* — These are usually PVC and polyurethanes coated fabrics. In general, the surface should be roughened to clean off dirt and grease and to increase the surface area as with rubber solings but in some cases the surface may be wiped over with solvent (*see* Note) or a specially prepared solution instead of removing the plastic surface.

NOTE — Methyl ethyl ketone is a suitable solvent to remove any surface finish and extraneous dirt. Apply the solvent with a damp pad avoiding flooding, level the wiped surface for 15 ± 5 min at room temperature before applying the adhesive.

4.1.9 *Fabric Uppers* — Normally no preparation is required for fabrics except for the dressing, which may need to be removed if it is very loose. With certain Sudene and Chatola fabrics, however, it is necessary to remove both the flock or sequins and the base adhesive as the base adhesive may be very tacky and weak, and may be a weak link in the attachment of the sole.

4.1.9.1 Fabrics made from man-made fibers such as rayon, nylon and polyester often present difficulty in sticking due to the adhesives not readily adhering to the fibers. This is especially true if the fibers are continuous filament as opposed to staple. It is usually necessary in this case to prepare the surface of the fiber by coating with special solution (like the adhesive along with isocyanate) that will adhere well to it.

4.2 Method of Preparation

4.2.1 *Wire Brush Roughening* — The wire brush is the most versatile tool and probably the best for most materials. For upper leathers, it is the only satisfactory tool for removing the grain surface of the leather. The wire brush has the further advantage that it removes plasts and irregularities from the lasted margin much more effective than scouring or cleaning with solvent. It is also one of the most effective tools for removing loose fiber from fleshy sole leather and can be used on all other soling materials.

4.2.2 *Chisel-Needle Roughening* — This type of tool is particularly useful for hard and horny sole leather for which it is better than a wire brush. Also, with certain rubbers, such tools can give as

good roughening as a wire brush. It is not very suitable for loose fibred leather soles and certain poorer quality rubbers. In such cases comparative test against a wire brush may be desirable.

4.2.3 *Scouring* — A coarse paper (30 grit or less) is used for scouring. This method of preparation is suitable for most rubbers. It is essential to watch that the paper does not clog and that it is replaced when worn, before contaminating the prepared surface. In cases where handling is unavoidable, as in stitching through a sole, it is a good practice to wipe the surface of the rubber with ligroin or white spirit and allowing the solvent to dry before applying the adhesive.

4.3 Adhesive Application — The adhesive manufacturer should provide along with the adhesive instructions as to the quantity of material to be used, the method to be employed for preparation and duration of curing period. As regards the application, the guidelines given in **4.3.1** to **4.3.4** may be followed.

4.3.1 *Method of Application* — Application of the adhesive may be done by machine or brush (*see* Note). Solvent based adhesive are applied by an extruder type of machine, although in some cases a roller type of machine may be used. The lattices can usually be applied by a roller type machine (two component adhesives are almost invariably applied by brush, because they will cause the applying machines to clog up if not cleaned out frequently).

NOTE — Application of adhesive may be done to both the adherents by brush stokes or machine in both the directions parallel to the direction of roughening.

4.3.2 *Absorbent Material* — Adequate amount of adhesive should be applied on leathers, fabrics and other absorbent materials. It would be a good practice to apply two coats of the adhesive on such materials. But adhesive applying machine are designed for single coat working and in general *a* single coat is quite satisfactory. With brush application of a second coat is often required. It is essential that a film of adhesive remains on the surface after drying.

4.3.3 *Non-absorbent Materials* — On rubber and other non-absorbent materials, a lighter coat is sufficient to give adequate dry film on the surface and it is advisable not to use too thick a solution (some adhesives are supplied in ‘thick’ and ‘thin’ grades).

4.4 Attachment

4.4.1 *Press* — For sole attaching, a press designed for this purpose should be used to obtain a good overall bond. The presses in use operate pneumatically consist of an airbag, water bag or a pad of soft rubber. The pressure should be applied through the pad box or through the arm holding the last. Whatever system is used, the press should be capable of applying sufficient pressure, without the pad wrapping round the shoe bottom, and with the pad extending to the whole area of the shoe bottom.

4.4.2 *Press Dwell* — The modern technique is to reduce the press dwell. Present two station presses operate at between 15 to 20 seconds dwell per shoe. The length of press dwell depends on the rate of set-up of the adhesive. This will vary to some extent with the type of footwear, characteristics of the adhesive, method of reactivation, etc. Solution activated adhesives require the longest press dwell, hence the use of multi-station presses; the heat reactivated and non-reactivated types of

adhesives require a shorter press dwell than solvent-activated adhesives. The length of time the shoe needs to be in the press may be determined in the factory by examining some shoes for any evidence of 'creep' in the bond. After they have been left for a day, the creep will show as legging of the adhesive at the points of greatest stress and may indicate that the press dwell was too short.

4.4.3 *Open time* — Open time is the time interval between applying the adhesive and assembling the bond. The appropriate open time depends on the properties of adhesive and to some extent on the nature of adherends. Use an open time, recommended by the adhesive manufacture.

4.4.4 Green *Strength* — The minimum length of time which should be allowed between sole attaching and the *next* operation, will depend on the type of adhesive used and normally it is a matter of minutes.

5 HAZARDS IN USING SOLVENT BASED ADHESIVES

5.1 Inflammability of Solvents — The majority of solvents used in the adhesives are inflammable. Adhesives, therefore, should not be stored or used in the vicinity of flame, an electric fire, or other hot surfaces. Adhesive that are inflammable may be labelled accordingly.

5.2 Toxicity of Solvents — The vapours of practically all solvents used in adhesives are liable to cause toxic effects, if confined to small space. It is advisable to use adhesive with some form of extract system, or failing this, in a room with adequate ventilation. It is obviously, not a good practice to confine the use of adhesives to a corner of a room where there is no flow of air, thus enabling the concentration of the vapours *to* increase. When adhesives are applied by brush it helps if the adhesive is used from the dispenser rather than from an open tin or other open vessel. The advantage of a dispenser is that the exposed surface area of the adhesive is small thus minimizing both fire and toxicity risks.

5.3 Dermatitis from Adhesive — It has been found that most adhesives can cause dermatitis if allowed to be in contact with skin for an appreciable length of time. It is probable that the trouble usually occurs when the adhesive is allowed to dry on the skin and is left for many hours without being removed. The principal danger is that repeated exposure may produce sensitization (allergy) of the skin. Any further brief contact with the adhesive then causes skin irritation and inflammation. People who have not developed the allergy may not be affected.

5.3.1 The prevention of dermatitis arising from adhesive is not difficult and is essentially a question of cleanliness. The hands may be protected by using suitable barrier creams followed, after work, by hand cleaning creams which facilitate, the removal of the adhesive. This system of protection, and cleaning is preferable to the common practice of using solvent to remove adhesive after work. If a solvent is used, it should be an effective solvent for the adhesive and should be followed with an 'after work cream', to replace the natural oils removed from the skin.

6 TESTING

6.1 Toe Testing — After effecting a satisfactory bond, it is advisable to make regular check tests of normal production shoes. A suitable method for conducting adhesion test of sole has been given

in IS 8085 (Part 1). This is a non-destructive process control test, in which shoes are taken up to a pre-determined load which is less than the load that should be required to cause separation at the toe. If more than an occasional failure occurs a check-up is required; for this purpose some further shoes should be tested to failure and the soles should be stripped right back for examination of the bond.

6.2 Examination of the Bond — Having tested adhesion at the toe, much information may be gained by peeling back the sole to the waist and studying the type of breakdown occurring. This gives a rough assessment of the bond strength and the cause of weakness, if any, may be ascertained. This kind of examination coupled with a small scale wear trail, in which the shoes are pulled up on completion of the trial, will give a very good assessment of the quality and durability of the bond.

6.3 Type of Failure in Testing — A brief summary of the types of failure likely to occur and the reasons for these failures are given in **6.3.1** to **6.3.6.**

6.3.1 *Sole Leather Failure* **—** This is due to breaking of the sole leather fibers. A layer of these fibers may be seen adhering to the adhesive. If the test result is good, for example above 18 kg on the SATRA adhesion tester, this type of failure is quite usual and satisfactory. If the test result is low, this may often be due to too much loose flesh fiber being present.

6.3.2 Upper *Leather Failure* — This shows itself in just the same way as sole leather failure (**6.3.1**) though the fibers adhering to the adhesive are usually shorter and fewer in number. If upper leather failures occur at low loads, this may indicate failure to remove the grain layer in roughening, but this may also be an indication that the leather is unsuitable for adhesive work (for example certain semi-chromes and also goat skin leather). This type of failure may occur at high loads if the strength of the bond itself is exceptionally good.

6.3.3 *Rubber Plastic and Fabrics Failure* — This means that the material and that the adhesive bond is stronger than material. If the peeling load is low, the quality of the material is unsuitable for stuck-on work. With rubbers, especially microcellular, the tearing may not run deep into the material but may be confined to the tearing off a discontinuous surface layer. This may sometimes indicate undue weakening of surface by the roughening operation, and a different method of preparation may then be desirable.

6.3.4 *Lack of Adhesion to One of the Materials* — When the film of adhesive comes away from the surface of one of the materials, this usually denotes that the adhesive is not suitable for the material or that the material has had insufficient preparation.

6.3.5 *Adhesion Failure of Adhesive* — This is characterised by' legging' of the adhesive and is often an indication of (a) too short a drying time, (b) too short a dwell time, (c) joint tested before it has reached full strength, and/or (d) softening of the adhesive due to migration of plasticizer from PVC coated fabrics, or that of grease and oil from leathers. (Other impregnants that are now being used in leathers may have the same effect). Even if none of these causes are responsible, cohesion failures will occur if the adhesive is inherently the weakest link in the bond. Adhesive giving cohesion failures should generally be regarded as unsuitable for sole attachment.

6.3.6 *Non-coalescence of Two Adhesive Films* — This may be identified if shiny patches of the adhesive are seen where the two surfaces have not adhered, and may be due to (a) the adhesive being left too long between applying and pressing when no reactivation is used, (b) insufficient reactivation, (c) insufficient press time or pressure, or (d) application of insufficient adhesive (particularly with leather which may give a starved joint by soaking up the adhesive and leaving insufficient quantity on the surface. Insufficient pressure, may really be due to an application of uneven pressure, caused by an uneven lasted margin, or due to an unsuitable or incorrectly adjusted pad box on the press. It is important to look for such causes as to boost the air or hydraulic pressure on the machine.