



Continuous Sandwich Panel

User should check the validity of the Certificate by contacting Member Secretary, BMBA at BMTPC or the Holder of this Certificate.

Name and Address of Certificate Holder:

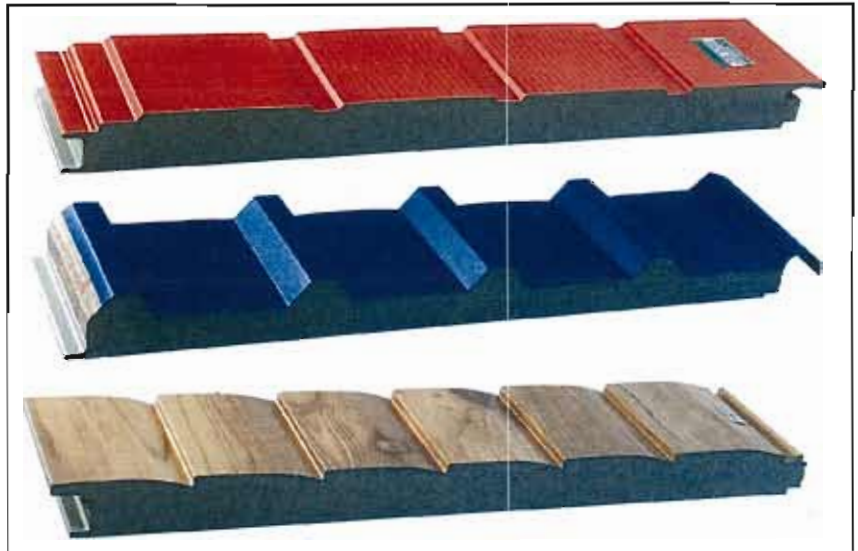
**M/s Sintex Industries Ltd.
Kalol (N. Gujarat) – 382721
Gandhinagar, India**

Performance Appraisal
Certificate No.

PAC No **1002-S/2011**

Issue No. **01**

Date of Issue: **29.06.2011**



bmtpc

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Ministry of Housing & Urban Poverty Alleviation
Government of India
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PERFORMANCE APPRAISAL CERTIFICATE
FOR
CONTINUOUS SANDWICH PANEL

ISSUED TO
M/s SINTEX INDUSTRIES LTD

STATUS OF PAC 1002-S/2011

S.No	Issue No.	Date of Issue	Date of renewal	Amendment		Valid up to (Date)	Remarks	Signature of authorized signatory
				No.	Date			
1.	2.	3.	4.	5.	6.	7.	8.	9.
1	01	29-06-11	29-06-13	--	--	28-06-13	--	

PAC No. 1002-S/2011

Issue No. 01

Date of issue: 29 - 06 - 2011

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PART I CERTIFICATION

I.1 CERTIFICATE HOLDER: M/s Sintex Industries Ltd.
Kalol (N. Gujarat) – 382721
Gandhinagar, India
Phone No. 02764-253500
Fax No. 02764-253800

I.2 DESCRIPTION OF PRODUCT

I.2.1 Name of Product – Continuous Sandwich Panel

I.2.2 Brief Description –Continuous sandwich panels are of lightweight modular design for easy & quick assembly. These insulated walls along with proper air conditioning and proper thermal management system are able to bring about direct savings on opex. Sandwich composite panels have emerged as viable alternatives to the traditional construction materials in the building primarily due to their strength & stiffness, low thermal conductivity & adequate durability. The major advantages of such layered construction are their structural rigidity in relation to its weight, quick & easy installation and low labour cost. Sandwich panels are generally layered construction composed of thin facing bonded to a core. This facing carry most of the applied load and provides the panel with its stiffness & strength characteristics. The core acts to separate the facing & transmit shear forces between them.

I.3 ASSESSMENTS

I.3.1 Scope of Assessment – Suitability of Continuous sandwich panels for construction of Cold storages, Official complexes, Schools, Laboratories & Industrial sheds etc. and for construction sites where the access is difficult.

Sizes – These panels are available in width of 1000mm, length as per requirement of the customer and thickness range of 30mm, 40mm, 50mm, 60mm, 75mm, 100mm and 150mm.

Types – Types of Continuous Sandwich Panels are:

SIP- 1001– Roof Panels (Crown type overlapping joint)

SIP- 2001-- Wall Panels (Concealed Fasteners-single profile)

SIP- 2002--Wall Panels (Concealed Fasteners- 3 profiles)

- I.3.2** **Scope of Inspection** – Scope of inspection included the verification of production, performance and testing facilities at the factory including competence of technical personnel, status of quality assurance and testing in the factory.
- I.3.3** **Assessment Summary**
- I.3.3.1** The assessment was done through inspection & laboratory testing equipment at the factory, conducting the tests in the factory and field observations of the panels.
- I.3.3.2** **Manufacturing & test facilities** – Manufacturing and test facilities available in the factory were found to be suitable & adequate to produce these panels as per the desired specifications. The PAC holder maintains testing laboratory with necessary equipment for quality assurance.
- I.3.3.3** **Competence of Technical Personnel** -- Persons involved in training were found to be well conversant with testing procedures required for the quality control of the product.
- I.3.3.4** **Inspection in actual use** – Four Prefabricated shelters made with these panels, installed during the year 2009 in the factory and at Satyamev Jayate School in Ahmedabad was inspected. They showed no distress & were found to be functioning satisfactorily.
- I.3.3.5** **Quality Assurance Procedure** – The firm follows a defined Quality Assurance System for production of these sandwich panels (See Quality Assurance Plan attached as Annexure).
- I.4** **USES OF THE SANDWICH PANELS & THEIR LIMITATIONS**
- I.4.1** **Design Data** – The data and information provided in Part II of this Certificate shall be used for selection of the size & dimensions of these panels.
- I.4.2** **Storage & handling at the user end before installation**

damage to the faces & edges. These panels shall not be dragged along the surface but shall be lifted clear of any surface on which they are stored.

I.4.3 Tests of the panels

I.4.3.1 The samples of these panels tested as per relevant Standards listed in Part V of this Certificate have met the requirements namely Impact, Slamming, Flexural Strength, Water absorption, Dimensional stability, Fire propagation index, Overall Thermal and Soundness transmission loss, Gravity etc. in accordance with the test report of M/s CIPET and the assembled panels got tested & checked against Seismic evaluation, wind & other loads and stability by CBRI, Roorkee and IIT, Delhi which lead to the conclusion that they can be used as panels for schools, telecom shelters and offices provided they are installed in accordance with manufacturer's instructions & guidelines.

I.5 CONDITIONS OF CERTIFICATION

I.5.1 Technical conditions –Raw materials and the finished product shall conform to the requirements given in Clause II--2.2.

I.5.2 Quality Assurance – The Certificate Holder shall implement & maintain a quality assurance system in accordance with Quality Assurance Plan given in the Annexure attached with this Certificate.

I.5.3 Handling of User Complaints

I.5.3.1 The Certificate holder shall provide quick redressal to consumer/user complaints proved reasonable & genuine and within the conditions of warranty provided by him to customer/purchaser

I.5.3.2 The Certificate holder shall implement the procedure included in the SQA. As part of PACS Certification he shall maintain data on such complaints with a view to assess the complaint satisfaction and suitable preventive measures taken.

I.6 CERTIFICATION

I.6.1 On the basis of assessment given in Part III of this Certificate & subject to the conditions of certification, use & limitations set out in this Certificate and if selected, installed & maintained as set out in Part I & II of this Certificate, the panels covered by this Certificate

PART II CERTIFICATE HOLDER'S TECHNICAL SPECIFICATIONS

II.1 GENERAL

II.1.1 The PAC holder shall manufacture these panels in accordance with the requirements specified in the relevant Standards and Clause II – 2.3.

II.2 SPECIFICATIONS FOR THE PRODUCT

II.2.1 **Specification** – The specifications for raw materials & finished panels shall be as per performance criteria when tested in accordance with the relevant Indian Standards listed in Part V of this Certificate.

II.2.2 Technical Specifications

II.2.2.1 Raw Materials

(1) **GI pre-coated Sheet**

(i) Chemical & Mechanical Properties -- Shall conform to IS 14246:1995

(2) **Polyurethane Foam** – Shall conform to IS 12436:1988

(i) Isocyanate : Polyol ratio 1:1.25
(ii) Density of PUF $40 \pm 2 \text{ Kg/m}^3$
(iii) Tensile strength of PUF $2.32 \text{ Kg/m}^2 \text{ min.}$

(3) **Complete Sandwich Panels**

(i) Compressive Strength at 10% $1.15 \text{ Kg/m}^2 \text{ min.}$
(ii) Thermal Conductivity at 10°C $< 0.02 \text{ W/M}^\circ \text{K}$
(iii) Temperature Range $-80^\circ \text{C to } +100^\circ \text{C}$

II.2.2.2 Construction & workmanship

- (i) Continuous sandwich panels are made out of GI Pre-coated sheet on its outer & inner surfaces with the core injected with high density polyurethane foam (PUF). The edges are covered with GI pre-coated sheet profile section. The panels have highest fire rating and can resist wind pressure up to 150 Km /hr. These panels are suitable for all weather conditions and the polyester pre-coating on the GI sheets provide adequate protection from corrosion.
- (ii) These panels are fixed with tongue and groove method as per

II.2.2.3 Design—These panels are designed for withstanding wind velocity of 55m/sec. & for Seismic Zone V as per the reports submitted by the IIT, Delhi and CBRI, Roorkee.

II.2.3 Performance Characteristics of Continuous sandwich panels – These panels shall meet the following performance characteristics when tested in accordance with the relevant Standards:

S.No.	Performance Characteristics	Test Method	Acceptable Criteria
1.	Dimensional Stability (70°C for 7 days)	IS11239(Part3): 2009	Shall be $\pm 2\%$ max
2.	Wind Load	As per Appendix	Shall be suitable for 55m/sec
3.	Structural stability	As per Appendix	Shall be suitable for SBC of 10t/m ²
4.	Earthquake Resistance	As per Appendix	Shall be suitable for Seismic ZoneIV

II.2.4 Packing – Each panel shall be packed properly to ensure safe & defect free delivery to customers.

II.2.5 Marking -- Besides the identification mark of the PAC holder as manufacturer and any other marking he may use, the size and batch number shall be marked suitably on each panel.

II.3 SELECTION & INSTALLATION

II.3.1 The user/installer is responsible for proper selection and installation at site as per manufacturer's instructions. In this regard PAC holder shall provide proper guidance.

II.3.2 Choosing size and thickness –Appropriate size of the panels shall be chosen to suit the requirements of the user.

II.3.3 Handling – Continuous sandwich panels shall be carefully handled during storage or installation in order to prevent occurrences of damage to the faces & edges. The panels shall not be dragged along a stack or any surface but shall be lifted clear of a stack or any surface

II.3.4 Installation instructions

II.3.4.1 A panel is one of the parts of prefabricated structure.

II.3.4.2 These panels rest horizontally on wall panels & purlins

II.3.4.3 These are fixed on purlins with J-bolts & washers

II.3.4.4 A proper slope shall be maintained as per drawings

II.3.4.5 All roof sheets are fixed with proper overlapping

II.3.5 Good practices for installation & maintenance – Good practice as per details provided by the manufacturer shall be followed for installation of these panels.

II.4 MAINTENANCE REQUIREMENTS -- These panels shall be refinished in accordance with the recommendations contained in technical literature of the PAC holder. If necessary, the panels should be removed from the prefabricated structure so that the finishes of the edges can be carried out properly.

II.5 SKILLS / TRAINING NEEDED FOR INSTALLATION -- No special skills other than normal skills of a good mason and carpenter shall be needed for installation of these panels.

II.6 GUARENTEES/WARRANTIES PROVIDED BY THE PAC HOLDER- The PAC holder shall give warranty for a period of at least one year after installation of the panels.

II.7 SERVICES PROVIDED BY THE PAC HOLDER
The users/customers shall ascertain from the PAC holder the type of service, the PAC holder is prepared to provide.

PART III BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE

III.1 BASIS OF ASSESSMENT

III.1.1 The technical basis for assessment is as per the standards listed in Part V

- (iii) Assessment of quality assurance procedures implemented in the factory
- (iv) Tests done in the factory in the presence of third party namely RITES on random samples of the panels taken by IO during inspection on the basis of performance characteristics given by the manufacturer
- (v) Tests got done in independent laboratories namely CIPET, CBRI & IIT Delhi by the manufacturer
- (vi) Inspection of these panels in service

III.2 MANUFACTURING PROCESS

III.2.1 Raw Materials & pre-coated sheets are procured from market. Then upper and lower coils of GI pre-coated sheets are loaded, profiled & rolled as per drawing. Pre-heating of GI coated sheet, spraying of Polyol & Isocyanate in-between GI pre-coated sheet are done. Double belt conveyor passes as per thickness and cooling conveyor cools the panel. Panel is cut as per specification and the end surface is cleaned.

III.2.2 Inspections & testing is done at appropriate stages of manufacturing process. The inspected panels are stored & packed to ensure that no damage occurs during transportation. As part of quality assurance regular in process inspections are carried out by the trained personnel of the PAC holder.

III.3 FACTORY INSPECTIONS

III.3.1 The factory was inspected by the technical representative of the Council. During inspection the entire manufacturing process along with the equipment was inspected. The manufacturing process was found to conform to the process description given in the Annexure. The in-process inspection and the inspection of the finished panels were in accordance with the QAP approved as a part of the requirements for grant of this PAC. It is the responsibility of the PAC holder to maintain and calibrate equipment for manufacturing and testing periodically to manufacture these panels in accordance with the specified parameters.

III.4 LABORATORY TESTS DONE FOR ASSESSMENT

III.4.1 Testing of samples

III.4.1.1 In the factory – The tests listed in the report i.e. Visual appearance, Dimensional stability, Flexural strength, Water absorption, Water

factory in the presence of third party namely RITES on random samples of panel taken by the IO for checking the product as well as related test equipment. The tests were conducted using standard test methods covered by the relevant Standards listed in Part V of this Certificate. The samples passed in all the tests conducted.

III.4.1.2 In Independent laboratories – The performance tests for these panels specified in relevant Standards and listed below have been got done on the samples of the panels in independent laboratories namely CIPET, Ahemdabad, CBRI, Roorkee* and IIT, Delhi by the manufacturer. The samples conform to the tests as per the performance requirements and specifications given by the manufacturer.

Tests done in independent laboratories

S.No.	Parameters	Test Method/ Requirement	Results Obtained
I. Physio-mechanical Properties			
I.1	Dimensional Stability (%) (70°C for 7 days)	IS 11239:2009 Shall be $\pm 2\%$ max	Negligible
I.2	Visual appearance	Visual -- Shall be free from any surface defects	Free from surface defects
I.3	Water absorption (i) With sealing edge (ii) Without sealing edge	ASTM D 570:1998	Nil 7.20%
I.4	Flexural strength	IS 9162:1979	5.6 MPa
I.5	Density (PUF)	ASTM D 792:2000 Shall be not less than 36 Kg/m ³	39 Kg/m ³
I.6	Pressure head test	IS 13826:1993 There shall be no leakage	No leakage
I.7	Water penetration test	IS 2645:1975 -- There shall be no seepage	No seepage
I.8	Sound transmission loss	As per Appendix	22.64 dB (Avg)
I.9	Fire propagation index	BS 476 (Part 6)	6.67
I.10	Load test (260 Kg/m ²)		

	transmittance - U value	Shall be 0.027 W/m ² K	0.49 W/m ² K
II. Typical Properties			
II.1	Visual	IS 4020: 1998 (Part 1) Shall be free from defects	Free from visual defects
II.2	Dimensions & Squareness	(Part 2) – Shall be within tolerances specified Shall not exceed 1 in 500	1000mm x1000mm Possess squareness property
II.3	General Flatness	(Part 3) – Twist, warping & cupping < 1.5 mm	No twist, warping & cupping observed
II.4	Slamming	(Part 10) – Shall not cause any visible damage	No visible damage observed
II.5	Screw Withdrawal	(Part 16) – No visible damage to the surface	No embossing /chipping observed
II.6	Central Point load	Avg. deflection 15 mm	Deflection 0.03 mm
II.7	Seismic evaluation	Shall be within Seismic Zone V	Max. earthquake acting as per Seismic Zone V
III. Impact Tests			
III.1	Impact indentation	IS 4020: 1998 (Part 5) No defects such as cracking , tearing etc.	Only depression at a point of falling
III.2	Falling hammer impact	IS 2380:1977 Puncture or visible fracture at the bottom	No puncture at the bottom& depression at top face
III.3	Impact load	Avg. failure height≤1.5m	No failure
III.4	Impact shock (soft & light body)	IS 4020: 1998 (Part 8) No visible damage	Damage free
III.5	Impact shock (soft & heavy body)	Withstand without any permanent deformation and deterioration	Damage free
IV. Fire Tests			
IV.1	Fire Ignitability	BS 476 (Part 5) – ‘P’ Shall not easily ignitable	Not easily ignitable ‘P’ category
IV.2	Fire propagation	BS 476 (Part 6)-- Higher value of I & i1 more hazardous, easily ignitable & rapid burning	I=6.67 (i1 =2.74+ i2=2.37+ i3=1.56)
IV.3	Surface spread of flame	BS 476 (Part 7) Shall be Class 1	Class 1 (low flame spread)

III.4.1.3 Moreover, a shelter for M/S BSNL made out of these panels have also been got tested for Gravity and Wind Load by the manufacturer from IIT, Delhi and found safe & adequate in accordance with relevant Indian Standards.

III.5 INSPECTION & SUPPLY OF SANDWICH PANELS: - Four Prefabricated shelters, made with these panels, installed in the factory and at Satyamev Jayate School in Ahmedabad during the year 2009 were inspected. None of them showed any distress & were fully functional. The user had no complaints. Details of the prefabricated shelters supplied by the manufacturer during the period 2008-2010 are given below:-

<i>S.No.</i>	<i>Occupancy/Building</i>	<i>Location of Building</i>	<i>When installed</i>
1.	UP Rajkiya Nirman Nigam Ltd	Sitapur Road, Lucknow-226020	June, 2009
2.	Tower Vision India (P) Ltd	Chennai, Tamil Nadu	July, 2009
3.	PIPALKOTI HYDRO Project	Pipalkoti, Chamoli Uttarkhand,	June, 2009
4.	Satyamev Jayate School	Bopal, Ahmedabad	October, 2009
5.	INDUS Tower Ltd	Maharashtra	November, 2009
6.	ABG Shipyard Ltd.	Jageshwar, Vagara Distt. Bharuch-392130, Gujarat	January, 2010
7.	INDU Thermal Projects Ltd	Bhusawal, Maharashtra	April - 2010
8.	INTAS Pharma Ltd.	Pharmez, Ahmedabad	2010

PART IV STANDARD CONDITIONS

This certificate holder shall satisfy the following conditions:

- IV-1 The certificate holder shall continue to have the product reviewed by BMBA.
- IV-2 The product shall be continued to be manufactured according to and in compliance with the manufacturing specifications and quality assurance measures which applied at the time of issue or revalidation of this certificate. The Scheme of Quality Assurance separately approved shall be followed.
- IV-3 The quality of the product shall be maintained by the certificate holder.
- IV-4 The product user should install, use and maintain the product in accordance with the provisions in this Certificate.
- IV-5 This certificate does not cover uses of the product outside the scope of this appraisal.
- IV-6 The product is appraised against performance provisions contained in the standards listed in Part-V. Provisions of any subsequent revisions or provisions introduced after the date of the certificate do not apply.
- IV-7 Where reference is made in this Certificate to any Act of Parliament of India, Rules and Regulations made there under, statutes, specifications, codes of practice, standards etc. of the Bureau of Indian Standards or any other national standards body and the International Organization for Standardization (ISO), manufacturer's company standards, instruction/manual etc., it shall be construed as reference to such publications in the form in which they were in force on the date of grant of this Certificate (and indicated in Part V to this Certificate)
- IV-8 The certificate holder agrees to inform BMBA of their distributors / licensees whenever appointed by him and agrees to provide to BMBA a six monthly updated list thereof.
- IV-9 The certificate holder agrees to provide to BMBA feedback on the complaints received, the redressal provided, and the time taken to provide redressal on complaint to complaint basis as soon as redressal is provided. BMBA agrees to provide the certificate holder the user feedback received by it, if any.
- IV-10 If at any time during the validity period, PACH is unable to fulfill the conditions in his PAC, he should on his own initiative suspend using the PAC and notify Chairman, TAC the date from which he has suspended its use, the reason for suspension and the period by which he will be able to resume. He shall not resume without the prior permission of BMBA. He shall also inform, simultaneously, his agents, licensees, distributors, institutional, government, public sector buyers, other buyers and all those whom he has

IV-11 In granting this Certificate, BMBA takes no position as to:

- (a) The presence or absence of patent or similar rights relating to the product;
- (b) The legal right of the Certificate holder to market, install or maintain the product;
- (c) The nature of individual installations of the product, including methods of workmanship.

IV-12 BMTPC and the Board of Agreement of BMTPC (BMBA) take no position relating to the holder of the Performance Appraisal Certificate (PACH) and the users of the Performance Appraisal Certificate (PAC) respecting the patent rights / copy rights asserted relating to the product / system / design / method of installation etc. covered by this PAC. Considerations relating to patent / copy rights are beyond the scope of the Performance Appraisal Certification Scheme (PACS) under which this PAC has been issued. PACH and users of this PAC are expressly advised that determination of the Claim / validity of any such patent rights / copy rights and the risk of infringement of such rights are entirely the responsibility of PACH on the one hand and that of the users on the other.

IV-13 It should be noted that any recommendations relating to the safe use of the product which are contained or referred to in this Certificate are the minimum standards required to be met with when the product is installed, used and maintained. They do not purport in any way to restate or cover all the requirements of related Acts such as the Factory Act, or of any other statutory or Common Law duties of care, or of any duty of care which exist at the date of this Certificate or in the future, nor is conformity with the provisions of this Certificate to be taken as satisfying the requirements of related Acts.

IV-14 In granting this Certificate, BMTPC and BMBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the use of this product.

IV-15 The certificate holder indemnifies BMBA, its officers and officials involved in this assessment against any consequences of actions taken in good faith including contents of this certificate. The responsibility fully rests with the certificate holder and user of the product.

IV-16 The responsibility for conformity to conditions specified in this PAC lies with the manufacturer who is granted this PAC. The Board (BMBA) will only consider requests for modification or withdrawal of the PAC.

IV-17 The PAC holder shall not use this certificate for legal defense in cases against him or for legal claims he may make from others.

PART V LIST OF STANDARDS & CODES USED IN ASSESSMENT

Part V.1 Standards - These Standards are referred for carrying out particular tests only and do not specify the requirement for the whole product as such.

Part V.1.1 IS 875 (Part 3):1987 – Code of practice for Design loads (other than earthquake) for Buildings & structures

Part V.1.2 IS 1893 (Part 1):2002 – Criteria for earthquake resistant design of structures – General provisions & buildings

Part V.1.3 IS 2380:1977 –

Part V.1.4 IS 3346: 1980 – Method of determination of Thermal Conductivity of thermal insulation materials

Part V.1.5 IS 4020(Parts 1-16):1998 – Door shutters – Method of tests

Part V.1.6 IS 9162:1979 – Method of tests for Epoxy resins, Hardeners and Epoxy resin composition for floor toppings

Part V.1.7 IS 11239 (Part 3):2009 – Method of test for rigid cellular thermal insulation of materials.

Part V.1.8 IS 13826(part 4):1993 – Bitumen based felts – Method of test for Pressure head test

Part V.1.9 IS 12436:1988 – Specifications for Performed Rigid Polyurethane foam for thermal insulation

Part V.1.10 IS 14246:1995 – Specifications for continuously pre-painted galvanized steel sheets and coils

Part V.1.11 ASTM C 177 – Standard Test Method for Thermal Conductivity of Polyurethane Foam

Part V.1.12 ASTM D 570:1998 -- Standard test method for water absorption of Plastics

Part V.1.13 ASTM D 792:2000 – Standard test Method for Density and Specific gravity of Plastics

Part V.1.14 BS 476 (Parts 5, 6, 7) -- Fire Tests on Building Materials & Structures – Method of test of Fire Ignitability, Fire Propagation & Surface spread of flame of Products

Part V.2 Company Standards of the PAC holder – The branded design & specifications of the raw materials and finished product are as submitted by the manufacturer. The PAC holder has to make

CERTIFICATION

In the opinion of Building Materials & Technology Promotion Council's Board of Agreement (BMBA) **Continuous Sandwich Panel** bearing the mark Manufactured by M/s Sintex Industries Ltd is satisfactory if used as set out above in the text of the Certificate. This Certificate **PAC No.1002-S /2011** is awarded to **M/s Sintex Industries Ltd.**

The period of validity of this Certificate is as shown on Page 1 of this PAC. This Certificate consists of pages 1 to 30.



Embossin
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Seal
of
BMBA

On behalf of BMTPC Board of Agreement

New Delhi, India

Place

Date

Chairman, Technical Assessment Committee (TAC) of
BMBA & Member Secretary, BMTPC Board of
Agreement (BMBA) Under Ministry of Housing and
Urban Poverty Alleviation, Government of India

Member Secretary, BMBA
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Core SA, 1st Floor, India Habitat Centre, Lodhi Road,
New Delhi-110 003

PART -- VI ABBREVIATIONS

Abbreviations

BMBA	Board of Agreement of BMTPC
BMTPC	Building Materials and Technology Promotion Council
CPWD	Central Public Works Department
ED	Executive Director of BMTPC
IO	Inspecting Officer
MS	Member Secretary of BBA
PAC	Performance Appraisal Certificate
PACH	PAC Holder
PACS	Performance Appraisal Certification Scheme
SQA	Scheme of Quality Assurance
TAC	Technical Assessment Committee (of BMBA)

Performance Appraisal Certification Scheme - A Brief

Building Materials & Technology Promotion Council (BMTPC) was set up by the Government of India as a body under the Ministry of Housing & Urban Poverty Alleviation to serve as an apex body to provide inter-disciplinary platform to promote development and use of innovative building materials and technologies laying special emphasis on sustainable growth, environmental friendliness and protection, use of industrial, agricultural, mining and mineral wastes, cost saving, energy saving etc. without diminishing needs of safety, durability and comfort to the occupants of buildings using newly developed materials and technologies.

During the years government, public and private sector organizations independently or under the aegis of BMTPC have developed several new materials and technologies. With liberalization of the economy several such materials and technologies are being imported.

However, benefits of such developments have not been realized in full measure as understandably the ultimate users are reluctant to put them to full use for want of information and data to enable them to make informed choice.

In order to help the user in this regard and derive the envisaged social and economic benefits the Ministry of Housing & Urban Poverty Alleviation has instituted a scheme called Performance Appraisal Certification Scheme (PACS) under which a Performance Appraisal Certificate (PAC) is issued covering new materials and technologies. PAC provides after due investigation, tests and assessments, amongst other things information to the user to make informed choice.

To make the PACS transparent and authentic it is administered through a Technical Assessment Committee (T AC) and the BMTPC Board of Agreement (BMBA) in which scientific, technological, academic, professional organizations and industry interests are represented.

The Government of India has vested the authority for the operation of the Scheme with BMTPC through Gazette Notification No. 1-16011/5/99 H-II in the Gazette of India No. 49 dated 4th December, 1999.

Builders and construction agencies in the Government, public and private sectors can help serve the economic, development and environmental causes for which the people and Government stand committed by giving preference to materials and technologies which have earned Performance Appraisal Certificates.

Further information on PACS can be obtained from the website: www.bmtpc.org

ANNEXURE

BUILDING MATERIALS & TECHNOLOGY PROMOTION COUNCIL

QUALITY ASSURANCE PLAN FOR CONTINUOUS SANDWICH PANEL

S.No	Parameters to be inspected	Requirement Specified	Test Method	Frequency Of Testing
I. G.I. PRE-COATED SHEET				
I.1	Visual	Shall be free from any surface defects with proper marking/printing	Visual	For every lot
I.2	Mechanical, Chemical & Coating properties	Shall conform to IS: 14246:1995	Conform to IS : 14246:1995	Verifying manufacturer's Test certificate & once in a year in Govt. approved Lab
II. CSP PANEL				
II.1	Visual	Shall be free from any surface defects like scratches, dents & de-shaping	Visual	As per sampling plan
II.2	Dimensions	Shall be within tolerance limit of +2mm & -1mm	Measuring tape /vernier caliper/any suitable Measuring instrument	--do-
II.3	Thickness	Shall be within tolerance limit of +1mm & -1mm		-do-
II.4	PUF Density	Shall not be less than 36Kg/m ³	Shall conform to ASTM D 792-2000	-do-
II.5	Thermal Conductivity	Should be less than 0.02 W/M° K	Shall conform to ASTM C 177	Once in 6 months or whenever product material/ design

III. ASSEMBLED SHELTER				
III.1	Visual	Shall be free from any surface defects like scratches, dents & de-shaping	Visual	As per sampling plan
III.2	Dimension	Shall be with in tolerance limit of +2mm & -1mm	Measuring tape/vernier caliper	For every shelter
III.3	Structural stability like Wind load, Earth quake load & Live load	As per design calculations from Govt. approved Institute for Structural stability	As per design calculations from Govt. approved Institute	Once during product validation

EXCERPTS OF THE CBRI REPORT ON CONTINUOUS SANDWICH PANELS

A. SCOPE OF WORK

A.1 Physico- mechanical properties

Density, Water absorption, Water penetration, Dimensional stability, Water pressure head test, impact properties (indentation, falling hammer impact, impact load and large and soft body impact) slamming.

The physico-mechanical properties of sandwich panels are given in Table 1. The density of panels is 0.4 g/cm^3 and its weight is 11 kg/m^2 . When seal edged samples are immersed in water, there is no weight gain after 24 hours. The dimensional stability of samples is assessed at 70°C for 7 days. It is found that samples are stable and there is no change in length and volume. During screw holding power, it is very difficult to screw the samples because of their steel facing. During water penetration and pressure head test, no seepage or leakage are noticed. During three point bending, the panels there is not brittle failure noticed. In some samples, delamination between the core foam and GI face is observed. The samples have screw withdrawal of 440 N. Slight embossing on the surface of panels is noticed. The load is carried out by only face material.

A.2 Performance characteristics

Loading test, Seismic evaluation, Thermal and sound insulation, load bearing and fire (ignitability, fire propagation index and surface spread of flame).

A.3 General properties of continuous sandwich panels are given in Table 2. The panels are free from visual defects such as cracking, tearing, pin holes etc. They have adequate squareness property when tested as per IS 4020. The samples mounted horizontally on the frame have not shown any twist, warping and cupping. The samples withstand against shocks of 5 kg and 30 kg sand filled leather balls after several blows from the specified height. The samples have not received any damaged when they fall from their own

A.4 Impact properties – The impact properties of continuous sandwich panel are given in Table 3. During impact indentation, dropping a steel ball (500 gm of dia 50 mm) on panel from 75 cm height exhibited no cracking, tearing or delamination. During impact load, the samples were not failed or holed when a 2.5 kg hemispherical ended striker steel ball dropped from 1.5 m height. On increase of drop height up to 2 m, there is no failure in the panels. Under falling hammer test, samples do not show any sign of puncture or a visual fracture at the bottom of the specimen. The weight of striker was 1.2 kg. In another test, when the panel is shocked 5 times with 5 kg sand filled leather ball, there is no visual damage observed on the panel surface. During heavy body impact test, the blow of 30 kg sand filled leather ball showed no damage on both the sides of panel. The results indicate that samples have adequate resistance against various kind of impact loads.

A.5 Loading test – Experiment on bending resistance of sandwich panels is carried out equivalent to the max. wind load (55m/sec wind speed zone) according to IS 875(Part 3):1987. Outside structural facing of composite panels is fixed in the steel frame as to be fixed in the actual conditions and placed horizontally on a test frame without any restraining force. Dial gauges were provided at three important locations such as central and quarter points respectively. The test load was applied in four increments through bricks. Deflections were observed at every increment of load, 24 hours of loading immediate after unloading condition and after 24 hours of unloading as presented in table 4. The surface of panels has not shown any cracking/ crushing on both the sides of loaded and unloaded surfaces. The core materials consisted of PUP are completely intact. The central deflection of the panels is in the order of 6 – 7 mm at a time of loading after shows that continuous sandwich panel has sufficient ductility in terms of deflections after applying 260 kg load. Its bending strength is 56 kg / cm² when tested as per ASTM D790. This indicates that the sample has an adequate toughness and good resistance to bending action. The composite panel also exhibited very good recovery even after 24 hrs continuous loading while the wind load will only act for very small duration. It is found that the continuous

A.6 Seismic evaluation – Seismic resistance is not an important criteria in design of non-load bearing walls. Since continuous sandwich panels are new composite materials to be used as wall panels in buildings, hence tested for max. earthquake load calculated according to IS 1893 (Part 1): 2002. Non-load bearing walls are vertically subjected to their dead weight only, and in case of continuous sandwich panel construction, the bottom most panel will be subjected to max. seismic weight. Assuming the building is situated in very severe seismic intensity zone i.e. Seismic Zone V, it was observed that the max. earthquake force acting on continuous sandwich panel is much less than the seismic weight acting on the bottom most panel.

A.7 Fire tests – The fire tests such as ignitability, surface spread of flame and propagation index of sandwich panels are given in Table 5. During ignitability test, the samples showed no flame and no extension of burring after removal of ignition source. This indicates that the sample belongs to 'not easily ignitable' and its performance is indicated by 'P' category as per BS 76(Part 5). The surface spread of flame test indicates the flame spread on the sample does not exceed the limit assigned for the class. No flaming droplets were observed. This indicates that samples possess no tendency to support the spread of flame across their surface. As per BS 476 (Part 7), sample belongs to class 1 category. The fire propagation test is carried out to measure contribution of material to the growth of fire. The difference between the values of temperature recorded for the materials and those obtained during the calibration run are used for the computation of a fire propagation index. The time-temperature data indicates that the sub index is 2.74 for 1 – 3 minutes, the sub index i_2 2.37 for 4 – 10 minutes and i_3 1.56 for 12 – 20 minutes. The overall fire propagation index of sandwich panel is 6.67. The low value of propagation index indicates that samples have less effect on accelerating the growth of a fire.

A.8 Overall thermal transmittances (U) of sandwich panels are given Table 6 & 7. The U decreases while thermal resistance (R) increases with the increase of thickness of the panels. This indicates that samples have satisfactory thermal performance. The computed U value of panels meet the minimum requirement of IS: 3792 for non AC non-industrial building (U value roof = 2.33; wall= 2.56 W/m²K). As per National Building Code, samples also meet the requirement of Air conditioned residential building (in case of roofs, panels should be more than 40 mm) – (U value roof = 0.58; wall = 1.16 w / m² K). For commercial building, the minimum thickness of

W/m²K). The sound transmission loss decreases with the increase of frequency. The average sound transmission loss is 22.64 dB showing adequate sound insulation property (Table 8). The results indicate that sandwich panels possess adequate thermal acoustic behavior to be used as a external / internal reinforcement walling material.

B. Conclusion and Recommendation

- Results indicate that continuous sandwich panels perform satisfactory against various loads, earthquake, impact, thermal & acoustic and reaction to fire. The panels have been found suitable as wall/ roof panels for use in prefabricated buildings and also use in existing building for various functions.

Table 1 Physio – mechanical properties of Continuous sandwich panels.

Property	Method	Value
Density (g/cm ³)	ASTM D 792:2000	0.39
Weight Kg/m ²)		10.71
Water absorption (%) after 24 hrs With sealing edge Without sealing edge	ASTM D 570:1998	Nil 7.20
Dimensional Stability (%) (70°C for days)	IS : 11239:2009	Negligible
Flexural strength (MPa)	IS : 9162:1979	5.6
Pressure head test	IS : 13826:1993	No leakage
Water penetration test (pressure 8 kg/cm ²)	IS : 2645:2003	No seepage
Fire propagation index	BS 476 (part 6)	6.67
Load test (260 kg/m ²)	IS : 875(Part3):1987	Deflection- At loading 6.70 mm After unlading 1.01 mm Recovery after 0.45 mm 24 hrs
Overall thermal transmittance – U values (W/m ² k)	IS : 3346:1980	(0.49 (50 mm thick)

Table 2 Typical properties of Continuous sandwich panels

Property	Acceptability criteria	Obtained value
General (IS: 4020-98 Part 1)	Free from visual defects	Free from visual defects
Dimension and Squariness (IS: 4020-98 Part 2)	Squareness Deviation more than 1 mm in a length of 500 mm	1000 mm x 1000 mm the samples possess squareness property
General Flatness (IS: 4020-98 Part 3)	Twist < 1.5 mm Cupping < 1.5 mm Warping < 1.5 mm	The samples mounted horizontally has shown no twist, warping and cupping
Slamming (IS: 4020-98 Part 10)	No visible damage caused in any part of the panel by fifty drops	After 50 times falling of its own dead weight, no visible damage observed on outside sandwich panel facing
Screw withdrawal (IS: 4020- 98 Part 16)	No visible damage to the surface either by delamination, or extra chipping off at the points of withdrawal	440 N, No embossing/ chipping noticed at the time of withdrawal from sandwich panel
Centre point load test (40 Kg load with 30 mm bearing)	Passed the average deflection of 15 mm	Deflection = 0.03 mm

Table 3 Various Impact tests conducted on Continuous sandwich panels

Property	Acceptability criteria	Value
Impact Indentation (IS : 4020)	No defects such as cracking, tearing or delamination	Only depression at a point of falling
Falling hammer impact (IS: 2380)	Puncture or visible fracture at the bottom of the specimen	No puncture at the bottom
Impact load	Average failure height of 50 samples should not be less than 1.5 m	No failure
Impact shock (soft and light body - IS: 4020)	No visible damage in any part of panel after 25 blows	Damage free
Impact thrust bearing (soft and heavy body – IS: 4020)	Withstand without and significant permanent deformation and without deterioration	Damage free

Table 4 Deflection in Continuous sandwich panels before and after loading

	Deflection (mm)					Deflection(mm)	
	Loading					Unloading	
Dial gauge	65 kg/m ²	130 kg/m ²	195 kg/m ²	260 kg/m ²	After 24hrs	Immediate	After 24hrs
1.	1.734	3.020	4.354	5.502	5.848	0.800	0.390
2.	1.840	3.460	5.010	6.300	6.690	0.880	0.660
3.	1.720	3.080	4.360	5.518	5.864	0.788	0.398

Table 5 Fire tests on Continuous sandwich panels

Test	Requirement	Value
Ignitability (BS476 part 5)	'P' not easily ignitable Or 'X' easily ignitable	'P' category
Fire propagation (BS 476 part 6)	Higher value of I & i ¹ , more hazardous, more easily ignitable & more rapid burning	i ¹ = 2.74 i ² = 2.37 i ³ = 1.56 I = 6.67
Surface spread of flame	Classification based on	

Table 6 Density and Thermal conductivity of Continuous sandwich panels

S.No.	Name of material	Density Kg/m ³	Thermal conductivity W/m K
1.	Steel	7850	52
2.	PUF	56.66	0.027

Table 7 Derived thermal properties of Continuous sandwich panels

Property	Sandwich panel (Polyurethane Foam)					
	2.5 cm	3.5 cm	4.0 cm	5.0 cm	6.0 cm	7.5 cm
Resistance (R)	0.92	1.30	1.480	1.85	2.22	2.77
Overall thermal transmittance	0.92	0.68	0.60	0.49	0.42	0.34
Volumetric heat capacity	15.02	15.76	16.13	16.87	17.60	18.71
Decrement factor (λ)	0.57	0.50	0.47	0.42	0.38	0.32
Phase lag(Φ)	4.26	5.22	5.67	6.54	7.38	8.59

Table 8 Sound transmission loss of Continuous sandwich panels

S. No.	Frequency (Hz)	Sound transmission loss (dB)
1.	100	10.00
2.	125	13.02
3.	160	16.30
4.	200	20.30
5.	250	22.80
6.	315	24.30
7.	400	25.00
8.	500	26.60
9.	630	28.00
10.	800	29.30
11.	1000	31.60
12.	1250	27.00
13.	1600	24.60
14.	2000	24.40
15.	2500	21.10
16.	3150	18.00
Average Sound transmission loss		22.64