



**Gypcrete[®]
Building
Panel /
Rapidwall[®]
Panel**

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

Name and Address of Certificate Holder:
Gypcrete Building India (P) Ltd.
134, Arihant Majestic Towers,
216, Jawaharlal Nehru Road,
Chennai – 600 107

Performance Appraisal
Certificate No.

PAC No **5 / 2003**

Issue No. **1**

Date of Issue: **31.01.2003**



bmtpc

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Ministry of Urban Development & Poverty Alleviation
Government of India
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**Performance Appraisal Certificate
for
Gypcrete Wall Panel
issued to**

**Gypcrete Building India (P) Ltd.
Majestic Ashirwad,
22, Sivasailam Street.
T. Nagar, Chennai 600 017**

STATUS OF PAC 5 / 2003

| S. No. | Issue No. | Date of Issue | Date of renewal | Amendment | | Valid upto (Date) | Remarks | Signature of authorized signatory |
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Pictures on top cover Legend (Number in brackets refers to S.No. in Table in Para I-3.4.1.1)

1. Model Residence, China (10)
2. Residence in Pennang, Malaysia (9)
3. Crow on the Hill, Sydney, New South Wales, Australia (4)
4. Wirinna World Resort, Adelaide, Australia (2)
5. Low cost houses for workers, Adelaide, Australia (6)

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I-1 Certificate holder

Gypcrete Building India (P) Ltd.
Majestic Ashirwad,
22, Sivasailam Street.
T. Nagar, Chennai 600 017
INDIA

I-2 Description of product

I-2.1 Name of the product - Gypcrete® Building Panel, also called Rapid Wall Panel.

I-2.1.1 Brand name - Both Rapidwall® and Gypcrete® Building Panel

I-2.2 Brief description

I-2.2.1 Gypcrete Building Panels are made of Gypcrete reinforced with micro strand glass rovings. The panels have hollow cavities. Gypcrete consists of calcined gypsum plaster (made using phosphogypsum, an industrial waste) to the extent of 96.5%. Potable water and the following chemicals are used in the manufacturing process:

- i. Silicon rapid water repellent
- ii. Plaster water proofing emulsion
- iii. Retarder
- iv. Setting consistency acid

I-2.2.2 The panels can be made upto 12 m length, 2.85 m height and 120 mm overall thickness. It can be made in smaller handlable sizes also. It can also be cut at construction sites to sizes as required by design and construction. See also Fig. 1.

I-2.3 Grade and Type -The panels are of one grade namely water and fire resistant grade and one type only.

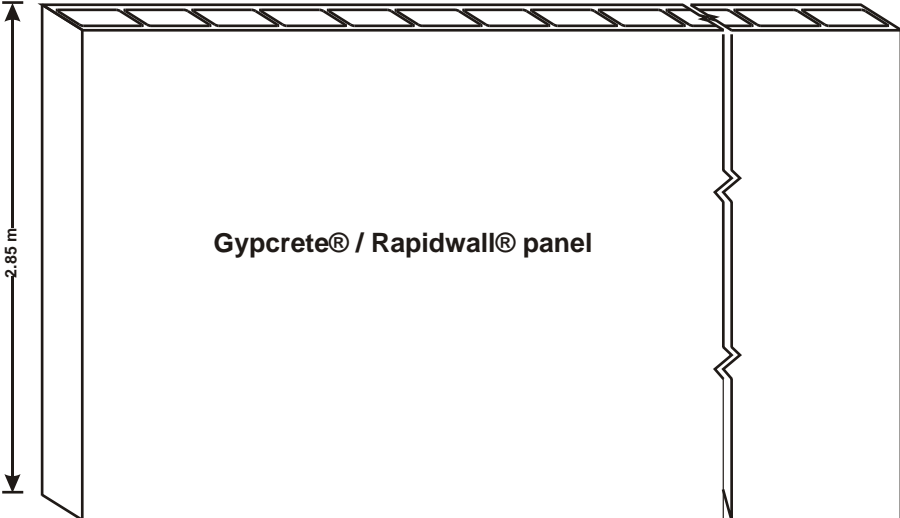
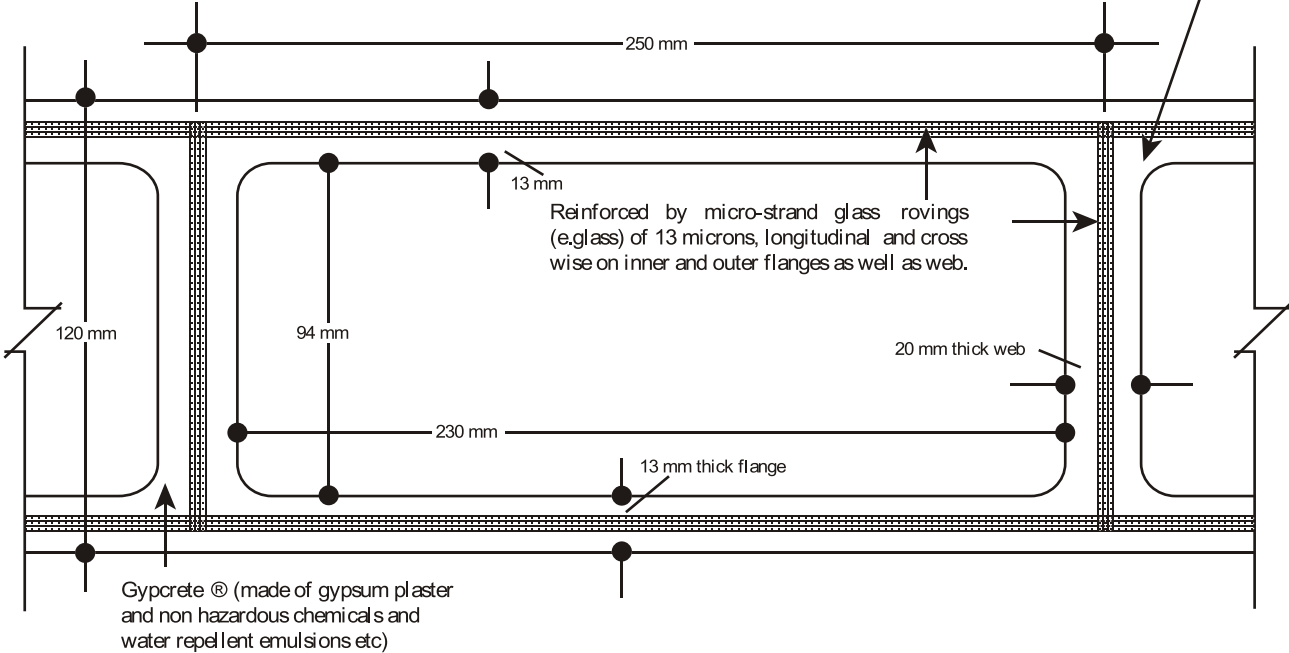
1-3 Assessment

1-3.1 Scope of assessment

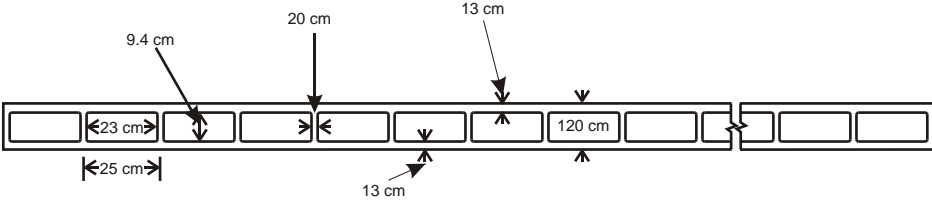
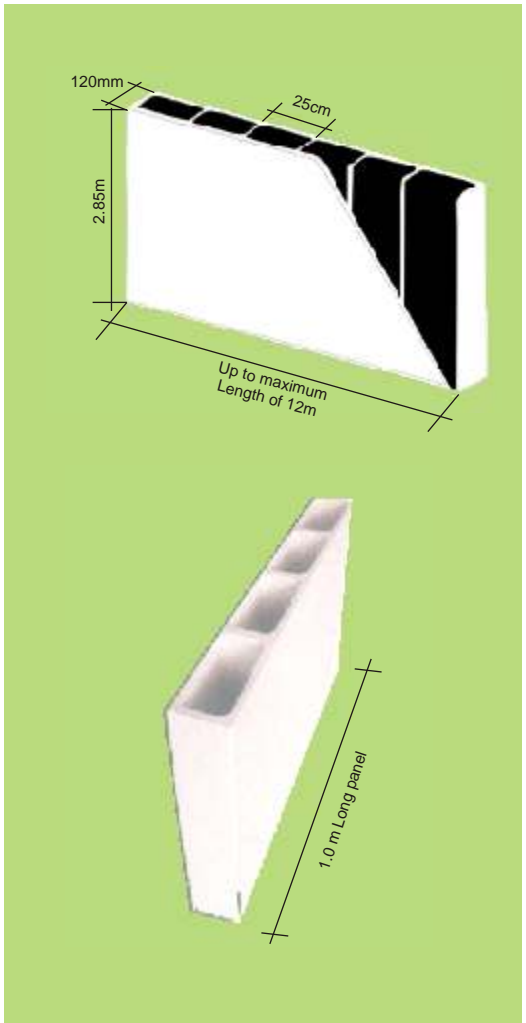
1-3.1.1 The scope of assessment included only basic properties of the product as obtained from tests and studies at two independent national laboratories on imported building panels and its potential for use:

- i. as load bearing wall panel
- ii. as mould or lost shutter for casting designed reinforced micro beams supported RCC roof slab or intermediary floor slab where the Gypcrete panel is taken as not contributing to the flexural strength of the slabs.

Gypcrete® (made of gypsum plaster and non hazardous chemicals and water repellent emulsions etc)



Panel in standing / walling position



Cross Section

Note 1 : A 12m long building panel has 48 cavities.
 Note 2 : Microstrand glass rovings are embedded at the centre of the inner and outer flanges and the web members.

I-3.1.2 Exclusions in assessment (see also (I-3.4.2)) This assessment did not include design, construction and maintenance aspects for buildings constructed using Rapidwall® panels. The following manuals satisfying the requirements of the relevant Indian standards are under preparation by this certificate holder and when submitted will be assessed for review of this Performance Appraisal Certificate.

- i. Code of practice for design of buildings using Gypcrete® / Rapidwall® building panels which amongst other details include design data, design charts, design procedures, joint detailing, design examples etc. for various types of structures and varying height of buildings. It would include limitations, if any.
- ii. Code of practice for construction of buildings using Gypcrete® / Rapidwall® building panels which would include construction procedures and practices, plant, machinery, skills required, construction scheduling, special considerations for joints, finishing, limitations etc. if any.
- iii. Code of practice for maintenance of buildings using Gypcrete® / Rapidwall® building panels.

I.3.2 Laboratory tests done for assessment Tests on imported panels sampled and provided by the holder of this certificate were carried out in two national laboratories. The test results are given in Annex V-2.

I-3.2.1 Users of this certificate may useful study “Rapidwall engineering design guidelines” of the Australian Collaborator of this certificate holder. Request for a copy may be made to this certificate holder. Three out of many other properties given in the “design guidelines” are reproduced below”

“Unfilled Rapidwall® panels”

| | |
|--------------------------------|------------------------------|
| Thermal expansion coefficient: | 12x10 ⁻⁶ mm/mm/°C |
| Water absorption: | 1hr 1% |
| | 24hrs 2.3% |
| | 72hrs 3.4% |
| Mohr hardness: | 1.6 |

I-3.3 Comparison of some test data with a few properties of some traditional walling units A statement of comparison of some test (see I-3.2) data of tests on Rapidwall® panel with properties of some conventional wall units for which Indian Standards exist is given in Annex V-3.

I-3.4 Basis of Assesment

I-3.4.1 Subject to the scope and exclusions set out in I-3.1.1, I-3.1.2 and I-3.4.2 the assessment of the potential for use of the building panels was based on:

- i. The test results, studies and recommendations given in Annex V-1 and Annex V-2 of two national laboratories on imported samples provided by the certificate holder and did not include assessment studies on actual structures in India, either under construction or in use as no construction has been done in India using the building panels.

- I. Test results on panels of a laboratory from Australia submitted by this, certificate holder.
- ii. Brief information submitted by this certificate holder on actual constructions using the panels as wall units and for floor/roof slab construction of single to 10 storey buildings in Australia, Malaysia and China (see I-3.4.1.1).
- iii. Rapidwall® Engineering Design Guidelines prepared for use in Australia a copy of which was provided by this certificate holder.
- iv. Brief description through drawing sketches of method of construction using Rapidwall® building panels submitted by this certificate holder.
- v. Brief specifications for the panels and raw materials used in the manufacture of the panels submitted by this certificate holder based on Australian experience.
- vi. Other documents submitted by this certificate providing information on costs, environment friendliness, savings in time taken for construction, energy saving in manufacture, construction and use of the building

I-3.4.1.1 The earliest constructions in Australia, Malaysia, and China on which this Certificate holder based His claims are as follows:

| S. No. | Country | Name & Place/ Location of Building | Occupancy | No. of Storeys | Geoclimatic Condition of the area | Load (L) bearing / non-bearing (NL) | Year of construction |
|--------|-----------|---|--------------------------------------|----------------|-----------------------------------|-------------------------------------|----------------------|
| 1. | Australia | Sydney park Village housing* Complex, Alexandria, Sydney | Residential/ multistoried apartments | 8 storeys | Hot & humid (coastal) | Load bearing | 1990 |
| 2. | | Wirinna World Resort at Seasons bay, Adelaide | Resorts | 4 storeys | Hot & cold (coastal) | Load bearing | 1994 |
| 3. | | Residence in Adelaide | Residential | 2 storeys | Hot & cold | Load bearing | 1992 |
| 4. | | Crown of the hill at Pennant Hill, Sydney, New South Wales | Residential– Multistoried Apartments | 9 storeys | Hot & cold | Load bearing | 1996 |
| 5. | | Penfolds Winery Chocolate factory in Great Western Victoria | Factory Building | Single storey | Hot & humid | Load bearing | 1995 |
| 6. | | Low cost houses for workers at Adelaide | Residential | Single storey | Hot & humid | Load bearing | 1998 |
| 7. | Malaysia | “Cool Home” built in the campus of University Mahapatra, Kuala Lumpur | Residential | Single storey | Hot & humid | Load bearing | 1999 |
| 8. | | Makro Super Market at Pennang, Malaysia | Commercial | Single storey | Hot & humid | Load bearing | 2001 |

| | | | | | | | |
|-----|-------|-------------------------|-------------|---------------|-------------|-----------------|------|
| 9. | | Residence in Pennang | Residential | Two storey | Hot & humid | Load bearing | 2001 |
| 10. | China | Model Residence | Residential | Two storey | Hot & humid | Load bearing | 1998 |

* *This project consists of 922 apartments. The first phase consisting of 370 apartments was completed in 1990. The entire project has been completed subsequently.*

I-3.4.2 Other assessment matters A total assessment as per the procedure of Performance Appraisal Certification Scheme should include the following and relating to experience of its manufacturer and use in India. These aspects as experiences in manufacture and use in India are not yet available and therefore do not form part of the present assessment (awaiting Indian experience) (see also I-4.2).

- a. Complete specifications for the product and the raw materials used and their nature as applicable in India
- b. Conformance to the relevant requirements specified in the National Building Code of India (NBC) and other relevant Indian Standards formulated by the Bureau of Indian Standards
- c. Conformance of the process and product to relevant Indian statutory requirements
- d. Manufacturing and test panels of required quality consistently
- e. Quality assurance procedures followed by the manufacturer
- f. The method of its use, design, construction, finish and maintenance including availability of design data, charts etc.
- g. The following aspects in relation to structures constructed using this product
 - i. Method for handling complaints from users of the product
 - ii. Environmental aspects in relation to raw materials, manufacturing of panels and their use
 - iii. Skills, training needed for using these panels
 - iv. Warranties/guarantees provided by the manufacturer
 - v. Services provided by the manufacturer
 - vi. Inspection of constructed buildings

I-3.4.2.1 Data on the following aspects based on Indian experience from actual construction and use in India are also not yet available. However, this assessment has examined the information provided by this certificate holder on the basis of experience in Australia, Malaysia and China of his Australian Collaborators.

- i. Safety against storms, cyclones, earthquakes, fire, exposure to rain
- ii. Structural safety
- iii. Durability
- iv. Ability of the structure to provide conditions for physical comfort in different geo-climatic zones in India
- V. Savings in time and cost of construction and life cycle cost compared to traditional and other convention technologies

I-3.4.3 Users of the panels are advised to obtain information and data on what are not included in this PAC from this PAC holder and make their assessment.

I-3.5 Comments on claims made by this certificate holder

I-3.5.1 The claims made by the certificate holder are listed below. He has based his claims on and has provided data from the experiences of his Australian Collaborator in use of the Rapidwall® panels in construction of buildings from single storey residences upto 17 storeys high in Australia and upto two storeys in Malaysia and China. The comments of the Assessors contained in this para on the claims have taken into account the points mentioned in I-3.4.1 and subject to limitations as per I-3.4.2. This certificate holder is yet to start production in India and no buildings have yet been constructed in India using Rapidwall® panels. After considering data referred above and the test results and recommendations of the two national laboratories which have tested the imported samples of the panels (see I-3.4.1 I, I-3.2), the assessors are of the view that the claims are sustained subject to assessors comments indicated, if any, in the items below. Though data based on Indian use are not available, the assessors are of the view that the benefits listed below can be realized in India also.

- i. Resistant to earthquake, cyclone Assessors comment : If properly designed, maintained and constructed as per relevant Indian Standards and the Codes of Design, Construction and Maintenance to be provided by this certificate holder the assessors are of the view this claim would be applicable in India.
- ii. Cost and time of construction reduction Assessors comment : Such reductions can be obtained in India Also.
- iii. Durability, Fire resistance Assessors comment : To be studied under Indian conditions.
- iv. Saves natural resources like water, agricultural land, river sand.
- v. Energy saving for air conditioning/heating.
- vi. Eco-friendly as it uses phosphogypsum to the extent of 96.5% - and industrial waste.
- vii. Plastering of walling and ceilings not required.
- viii. Lesser dead loads.
- ix. The panel manufacturing process does not result in emission of CO₂ Assessors Comment : To be studied when the factory in India goes into production.
- x. Considerable saving in embodied energy compared to traditional construction with brick, cement and cement concrete based products.
- xi. About 8% increase in carpet area compared to traditional construction.
- xii. Better internal thermal comfort Assessors comment : To be studied under Indian conditions.

I-4 Use of the panels and limitations

I-4.1 Use of Rapidwall® panels - The panels have potential for use for the following:

- i. Light weight load bearing walling without infill for residential occupancies upto two storeys. The panels can be used with or without non-structural core filling such as insulation, light weight concrete
- ii. For walling as load bearing wall with the cavities filled with concrete or without reinforcing steel as per design for residential occupancies upto 10 storeys. For structural design of such structures, services of an expert shall be required.
- iii. Wherever solid exterior wall is required to meet security needs, cavities can be infilled with light weight concrete, flyash-gypsum concrete or sand-cement-mix.
- iv. As prefabricated lost form work for high load bearing capacity vertical and shear load-bearing structural walling the cores in the panels may be filled with concrete, either with or without steel reinforcement, to provide load-bearing walls in residential constructions of upto 10 storeys.
- v. As partitions with insulation fill in the cavities.
- vi. As a compound wall / fencing suitably designed.
- vii. As cladding for industrial buildings.
- viii. As lost form work for RCC roofs and intermediate floors with integrally cast micro beams. The panels become flush plaster ceiling. However, the required floor, ceiling and roofing finishes should be provided.

I-4.2 Limitations of use the following are limitations in its use:

- i. Cannot be used for walls with high curvature
- ii. When used for roofing and intermediate flooring the panels are to be taken as not providing any structural support. The clear span is to be limited to 5m.

I-4.3 Special aspects of use The following should be taken care of designing and construction using the panels.

- i. Design should be done by competent structural engineers satisfying provisions of relevant Indian Standards and other related standards and statutory requirements.
- ii. Adequate care should be taken in the design, detailing and construction of all joints.
- iii. Skilled workmen trained in construction with Rapidwall® panels should be employed for construction.
- iv. It is advisable to study the full reports of the two national laboratories which have tested the product. These reports may be obtained from the holder of this certificate.
- v. The loading on structure in use shall not strictly exceed the loads for which the structure has been designed.

I-5 Conditions of Certification

I-5.1 This certificate shall be taken as only an expansion of the potential for use of the Rapidwall® panels.

I-5.2 Further submissions required of this certificate holder this certificate holder shall submit to BMBA the following in stages as soon as they are ready to review the certificate from time to time.

- i. The Codes of practice listed in I-3.1.2 as they are ready
- ii. The quality assurance procedures which will be followed in the factory to be set up by him in India for the manufacture of the panels.
- iii. Specifications for the raw materials used in the manufacture of the panels.
- iv. Request for sampling of panels for test as soon as production commences in the Indian factory
- v. Intimation as construction is undertaken in India using Rapidwall® panels manufactured in India.
- vi. Intimation of completion of a few buildings in India
- vii. Manufacture, construction, in use and maintenance data based on Indian Experience to substantiate claims made by this certificate holder (see I-3.5).
- viii. Submissions of non-conformity to any of the requirements, assertions etc. as and when they arise
- ix. Information, data, reports relating to items listed in I-3.4.2
- x. Procedure for dealing with complaints from users of the panel

I-5.3 Reassessment and review of the certificate The product will be reassessed and this certificate will be received as and when submissions are made as listed in I-5.2 and also relating to points listed in I-3.4.2 and modifications if any needed to this certificate will be issued as and when / if necessary.

I-5.4 This certificate holder should advise all users and potential users of the product the imperative need to get the designs done by component structural engineers, to employ those having necessary skills for supervision and construction as per applicable Indian Standards, statutory requirements and the Codes of practice (see I-3.1.2) to be provided by the certificate holder.

I-6 Certification

I-6.1 On the basis of the statements in I-3 in the Part I of this certificate and subject to use, limitations and special aspects of use in I-4.2 and I-4.3 of Part I and to conditions of certification listed in I-5 of Part I and Part III and subject to proper designing, detailing, construction, finish and maintenance, in the opinion of Assessors of BMBA the Rapidwall® panel, (also called Gypcrete® Building panel) manufactured by the Australian Collaborators of this certificate holder has potential for use for as listed in I-4.1 of this certificate.

PART-II CERTIFICATE HOLDER'S TECHNICAL SPECIFICATION

II-1 General Production of the Rapidwall® panels has not yet been commenced in India. Prior to production in India this certificate holder will prepare his company standards for the panels and for the raw materials that will be used. Conformance to these will be checked by BMBA when production in India commences at which time this certificate will be reviewed.

II-2 Specification for the panel

II-2.1 For wall panel this certificate holder will follow the specifications of his Australian collaborator for Rapidwall® panel.

II-2.1.1 The panels have not been checked against the specifications mentioned in II-2.1

II-3 Specifications for raw materials

II-3.1.1 Gypsum plaster This certificate holder has tested phospho-gypsum available as industrial waste material in India and has found it suitable for the production of gypsum plaster satisfying the requirements of the specifications.

II-3.1.2 Micro strand glass rovings This certificate holder has stated that micro strand glass rovings satisfying requirements of ISO 2797 and DIN 61855 will be used.

II-3.1.3 Other raw materials Water repellent emulsions, plaster water proofing emulsions, setting consistency acid and special adhesives are the other materials used in the production of the panels. Specification for these and their quality control will form part of the Scheme of Quality Assurance which will be approved by BMBA for implementation in the factory when production in India commences.

PART-III STANDARD CONDITIONS

III-1 This certificate only indicates the Gycrete building panels' potential for use.

III-2 The certificate holder should get the certificate revalidated after manufacturing of the panels in India, during which time all data and information indicated in this certificate as relevant for full assessment becomes available.

III-3 This certificate does not cover uses of the product outside the scope of this appraisal.

Place: New Delhi

Date of issue: 31.01.2003

Chairman, TAC

& Member Secretary, BMBA

for and on behalf of

Gycrete Building India (P) Ltd.

T. N. GUPTA

Executive Director

For GYCRETE BUILDING INDIA (P) LTD

Building Materials & Technology Promotion Council

PAC No. 57/2003

Urban Development & Poverty Alleviation
(Government of India)

Issue No 1

Date of issue: 31.01.2003

G-Wing, Nirman Bhawan, New Delhi

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Soni
Managing Director

- III-4 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), manufacture's company standards, instruction/manual etc., it shall be constructed as reference to such publications in the form in which they were in force on the date of grant of this Certificate or its renewal/amendment.
- III-5 The certificate holder agrees to inform BMBA of their distributors / licensees / franchisees whenever appointed by him and agrees to provide to BMBA a six monthly updated list there of.
- III-6 The certificate holder agrees to inform BMBA feed back on the complaints received, if any, the redressal provided, and the time taken to provide redressal on complaint to complaint basis as soon as redressal is provided. Till such time use of panels made in India commences, the certificate holder should provide complaint related information, if any, of the use of panels in other countries. BMBA agrees to provide the certificate holder the user feed back received by it, if any.
- III-7 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, franchisees, distributors, institutional, government, public sector buyers, other buyers and all those whom he has informed about his holding the PAC. He shall also inform all those who buy his product(s) during the period of suspension. He shall provide to BMBA at the earliest the list of who have been so informed by him.
- III-8 In granting this certificate, BMBA takes no positions 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 of the product, including methods of workmanship.
- III-9 BMTPC and the Board of Agreement of BMPTC (BMBA) take no position to relating to the holder of the Performance Appraisal Certificate (PACH) and the users of the Performance Appraisal Certificate (PAC) respecting the patent right / copy rights asserted relating to the product / system / design / method of installation etc covered by this PAC. Consideration 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.

Place: New Delhi
Date of issue: 31.01.2003


Chairman, TAC
& Member Secretary, BMBA
T. N. GUPTA
Executive Director

for and on behalf of
Gypcrete Building India (P) Ltd.

Building Materials & Technology Promotion Council
Ministry of Urban Development & Poverty Alleviation
(Government of India)
G-Wing, Nirman Bhawan, New Delhi
PAC No. 57/2003
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For GYPCRETE BUILDING INDIA (P) LTD.


Managing Director

- III-10 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 to 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.
- III-11 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.
- III-12 The certificate holder indemnifies BMBA, its officers and officials involved in this assessments against any consequences of actions taken in good faith including contents of this certificate. The Responsibility fully rests with the certificate holder and users of the product.
- III-13 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.
- III-14 The PAC holder shall not use this certificate for legal defense in cases against him or for legal Claims he may make from others.

Place: New Delhi

Date of issue: 31.01.2003


Chairman, TAC
& Member Secretary, BMBA

for and on behalf of
Gypcrete Building India (P) Ltd.

T. N. GUPTA
Executive Director
Building Materials & Technology Promotion Council
Ministry of Urban Development & Poverty Alleviation
(Government of India)
G-Wing, Nirman Bhawan, New Delhi

For GYPCRETE BUILDING INDIA (P) LTD.


Managing Director



PART IV LIST OF STANDARDS AND CODES USED IN THE ASSESSMENT

Iv-1 Indian Standards

V-1.1 IS:1893 (apart 1)-2002 Criteria for Earthquake resistant design of structures
Part 1 General provisions and Buildings

IV-2 Guidelines of the Australian Collaborator of the certificate holder

IV-2.1 Rapid Wall Engineering Design Guidelines

CERTIFICATION

In the opinion of Building Materials and Technology Promotion Council's Board of Agreement (BMBA) Gypcrete Building Panel also called Rapidwall® Panel manufactured currently by the Australian principals of Gypcrete Building India (P) Ltd. has the potential for use in construction of load bearing walls and as left-in-place formwork for intermediate floor and roof slabs as set out above in the text of this Certificate. This Certificate PAC No. 5 / 2003 is awarded to Gypcrete Building India (P) Ltd., 134, Arihant Majestic Towers, 216, Jawaharlal Nehru Road, Chennai – 600 107, INDIA

The period of validity of this Certificate is as shown on Page 1 of this PAC.
This Certificate consists of an unnumbered cover page and pages 1 to 24 which includes cover pages numbered 1, 23 and 24

On behalf of BMTPC Board of Agreement

New Delhi, India
Date: 31.01.2003


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

Annex V-1
[Para I-3.4.1 (i), Para V-2.2]
Assessment and Recommendations of two Indian National Laboratories

V-1.1 Assessment and recommendations of one of the national laboratories which conducted some physical tests only

From all the tests covered in their Report they have drawn the following conclusions and recommendations:

- a. The light weight (weight density of 450 kg/m^3) of Gypcrete® panels makes them ideal for use as infill panels in framed construction leading to considerable economy in the members of the frame beams and columns and foundations as compared to infill with conventional brick Masonry.
- b. The compressive strength of Gypcrete® panels is found to be around 2.7Mpa, on the gross area. This strength is adequate for the panels to be used in load bearing masonry up to two floors. This is in view of the low self weight of the panels themselves and also the absence of mortar joints. In case of higher number of floors (more than two floors), the cavities require to be filled (grouted) with concrete suitably. Use of concrete with Fal-G as cement instead of OPC can be an economic alternative.

Compressive strength of Gypcrete® panels filled with such concrete was found to be around 11.0 Mpa, which is adequate for up to 5 to 6 floors of load bearing construction. If higher strength are required for high rise building construction or where high concentrated loads come on Gypcrete® wall panels, reinforcement can be introduced along with concrete infill. The introduction of reinforcement in wall panels for buildings with more than two storeys can also be advantageously used to resist lateral forces due to wind, earthquake etc.,

- c. Being light, the panels sizes can be large that can result in some economy in bedding mortar. Use of large panels results in speeding up of construction. The latter aspect is very much relevant to our country in order to clear the huge backlog of housing shortage. The limitation in this respect may be the handling / lifting / erection of these panels.
- d. The Gypcrete® panels exhibited a water absorption of about 2 percent whereas the permissible water absorption for best quality bricks is 10 percent.
- e. The rain penetration test has clearly demonstrated the Gypcrete® panels are not affected by even high intensity rains. As such, they can be used for external cladding / walling of high-rise buildings and also in constructions at places of high rainfall.
- f. The two durability tests, viz. Wetting and drying, salt spray (corrosion) test, though carried out for relative smaller length of time, clearly showed the superior quality of Gypcrete panels with respect to their long term performance.

- g. The impact test has demonstrated the material against impact. The observed behavior of Gypcrete® panels is mainly due to the presence of fibers in the skin of the panels.
- h. The pull out loads recorded indicate that nailing and screwing can be done on the panels. These nails / screws can be used to suspend any weight or for fixing pipe lines or electric wiring without damaging the panels.
- i. Fire resistance test proved that the Gypcrete® building panels is a material with 4 hour fire rating and can withstand temperatures in the range of 700⁰ C to 1000⁰C.

V-1.2 Conclusion and recommendation of a second national laboratory which conducted some strength tests and shake table tests on models

The performance of the Gypcrete® building panel as a building material has been evaluated under static and dynamic (seismic) condition meeting the requirements of IS-1893 (Part-1) 2002 for Zone- V with 5% damping case and for soil strata condition. Seismic intensity and ground acceleration (g) specified for various seismic Zones as per IS-1893 (Part-1) 2002 are the following:

| Seismic zone | II | III | IV | V |
|---------------------|-------|------------|-------|------------|
| Seismic Intensity | Low | Moderation | Serve | Very Serve |
| Ground Acceleration | 0.10g | 0.16g | 0.24g | 0.36g |

Other related tests are also carried out and the results are as follows:

- i. The static compressive strength of Gypcrete® block is found to be 7.31 Mpa.
- ii. The flexure capacity of the Gypcrete® block has increased up to 40% with in-fill.
- iii. The concrete in-fill has improved the axial load carrying capacity for a wall panel of size 2800 x 775 x 125 mm to 1200 kN (120 tons), whereas empty panel (775 mm long) without in-fill carried an axial load of 290 kN (29 tons).
- iv. All the six housing models were subjected to an artificial earthquake, meeting the requirement of IS-1893 (Part-1) 2002 for Zone-V with 5% damping case and for soil strata Condition.

- v. All the six model houses withstood a maximum peak ground acceleration of 0.36g (200% design response spectrum equivalent to Maximum Credible Earthquake) given at the base on the shake table satisfying the provisions of IS-1893 (Part-1) 2002 Zone-V.

Based on the above study, it is found that the Gypcrete® building panel is suitable for use in seismic resistance houses / buildings with two stories in seismic zone-V, i.e. Very severe earthquake intensity in Indian conditions. The results given in this report can be used for extrapolating to stories higher than two, considering the effects of flexibility, natural period, damping co-efficient, elastic modulus (Young's modulus), additional mass effect and non-linearity. Proper design of steel reinforcement and cement concrete as per the structural design requirement is to be incorporated for multi-storied buildings. Also when the panel is used for walling and roofing or for any intermediate floor, seismic safety provisions are to be incorporated by providing suitable reinforcement for multi-storied buildings.

Note: Users are advised to study the full Reports which may be obtained from this Certificate holder

Annex V-2
(Para I-3.2, annex 3 Note 1 and Note 2)
Test results from two Indian National Laboratories

V-2.1 Strength test and other physical test conducted in one of the national laboratories (same as V-1.1).

| | | | |
|----|---|-------------|---|
| a. | Density As hollow units With cavities filled | Net density | 1.14 g/cm ³ 1.74 g/cm ³ |
| b. | Water absorption by weight | | 2% |
| c. | Rain penetration (subjected to shower like jet of water from a distance of 1.5m) (absorption after 2 hrs of continuous exposure) | | 0.57% |
| d. | Compressive strength on block size 300x300x122 mm | | |
| | Without fill | | 7179 MPa 79.4 kg/cm ² |
| | With fill (1:3:6 concrete) with flyash-lime-gypsum cent | | 11.3 MPa 113 kg/cm ² |
| e. | Fire resistance Blow lamp (blue flame temp 700 ⁰ -1000 ⁰ C kept at 50 mm from panel, flame directly hitting the panel, exposure 4h) (not standard test) | | Can be considered to have 4 th rating and withstand 700 ⁰ -1000 ⁰ C (recommendation of the testing laboratory) |
| f. | Durability | | |
| | i. Wetting and drying (20 cycles of 24 h wetting followed by 24 h drying) | | |
| | Average compressive strength | | 7.38 MPa 75.2 kg/cm ² |
| | ii. Salt spray test | | |
| | Test: 12 mm dia, 250 mm reinforcing rod embedded in concrete filled in the cavity, after 7 days curing hung in a salt chamber for 2 weeks (ASTM B 117-85) | | No apparent damage to the panel and to the reinforcement |

| | | | |
|----|--|--|-------|
| g. | Impact test cast iron ball 11.5 cm dia, weighing 5 kg dropped from a height of 1 m on to a Gypcrete® panel 1 m x 1 m supported all around the edges. Test done on hollow panel | Panel damaged after 5 drops at point of drop, no damage around the point | |
| | Infilled panel (concrete) (Improvised test) | Small dent, 5 mm deep after 10 drops | |
| h. | Pull out test 50 mm long ordinary nail driven 12 mm deep | | |
| | Pull out (hollow) | 157 N | 16kg |
| | Infilled with Fal-G concrete using wooden plug to 20 mm | 294 N | 30kg |
| | 25 mm screw, to depth of 12 mm | | |
| | pull out (hollow) | 245 N | 25 kg |
| | Infilled with Fal-G concrete (Improvised test) | 422 N | 42 kg |
| i. | Sound transmission class (STC) as per ISO 140-3-1996 | STC class 40 | |
| j. | Elastic modulus (Block of size 300 x 300 x 120 mm subjected to compression) | Modulus of elasticity $1.5 \times 10^5 \text{ kg/cm}^2$ | |
| | | Poisson's 0.15 to 0.23 Ratio | |

V-2.2 Building blocks and panels were tested under static loading in a second laboratory (same as V-1.2).

V-2.2.1 The over all size of the hollow Gypcrete® blocks tested was 300 x 300 x 120 mm. The flange and web thickness of the blocks was 13 mm and 20 mm respectively. A few blocks were filled with concrete of M 20 grade and the specimen were cured for 28 days. Axial compression test and flexure tests were conducted on blocks with and without fill.

V-2.2.2 Test results for blocks were as follows:

| | N/mm² | Kg/cm² |
|---|-------------------------|--------------------------|
| Average Compression Strength (without infill) | 7.31 | 73.1 |
| Average Compression Strength (with infill) | 18.0 | 180.7 |
| Average Strength in Flexure (without infill) | 1.8 | 18 |
| Average Strength in Flexure (with infill) | 2.6 | 26 |

V-2.2.3 The size of the panels tested and the test reports were as follows:

| | N/mm² | Kg/cm² |
|---|-------------------------|--------------------------|
| a. Flexure test by single point load (1400 x 1200 x 120 mm) | | |
| i. Flexure strength by single point load (without infill) | 2.125 | 21.25 |
| ii. Flexure strength by single load (with infill) | 2.080 | 20.80 |
| b. Flexure strength by double point load | | |
| i. Flexure strength by double point load (with infill) | 3.800 | 38.00 |
| ii. Flexure strength by double load (without infill) | 4.590 | 45.90 |
| c. Axial Compression (vertical load test) [2850 (height) x 200(width) x 120 mm (thick)] | (kN) | (Tonnes) |
| Axial vertical load (without infill) | 281.70 | 28.17 |
| The axial load on empty panel without concrete infill should be restricted to 210 KN. The panel needs filling of concrete and steel beyond this load capacity as per design requirements. | | |
| d. Axial Compression (vertical load test) [2850 (height) x 200(width) x 120 mm (thick)] | | |
| Axial vertical load (with infill) | 1200.00 | 120.00 |

V-2.2.4 Evaluation of seismic performance of Gypcrete® panels in the second national Indian laboratory.

V-2.2.4.1 Shaking table tests where done on six model houses single storeyed, base slab made of reinforced Gypcrete® panels and a composite roof panel of Gypcrete® and reinforced concrete, U and H shape, three different infill configurations, base slab sizes 2.24 m x 2.24 m. These models were subjected to dynamic tests (seismic condition). Corresponding to Zone V of IS 1893 (Part 1)-2002 with 5% damping. All models withstood a maximum peak ground acceleration of 0.36 g. Two models showed undesirable hair line cracks at the bottom portion near the joints between the base slab and wall panel and wall to wall joints. The remaining 4 models did not show any structural cracks. In a few models houses with all in-fills in the wall panels were concreted, showed hairline cracks along the edges of the end panels, these end panels were also showing delamination or splitting on their end face.

**Annex V-3
(Para I-3.3)**

Comparison of some test data of Rapidwall® with some conventional wall units

| Item | IS Code | Description | Strength requirement as per IS Code | | Comparative value of Gypcrete® building panel (without infill) (see note 2 below) |
|-------|-----------------------|--|--|--|---|
| | | | 4 | 5 | |
| 1 | 2 | 3 | 4 | 5 | 6 |
| V-3.1 | IS 1077:1976 | Common burnt clay building bricks | Compressive strength Water absorption (24 hrs) | =35kg/cm ² (3.5 Mpa) <20% (upto class 12.5) <15% (higher class) | 73.1 kg/cm ² (7.31 Mpa) < 2% |
| V-3.2 | IS 2180:1988 | Heavy duty burnt clay building bricks | Compressive strength Water absorption | ≥ 40kg/cm ² (4 Mpa) < 10% | 73.1 kg/cm ² (7.31 Mpa) < 2% |
| V-3.3 | IS 2222:1991 | Burnt clay perforated building blocks | Compressive strength Water absorption | > 7 kg/cm ² (0.7 Mpa) < 15% | 73.1 kg/cm ² (7.31 Mpa) < 2% |
| V-3.4 | IS 2849:1983 | Non-load bearing gypsum partition blocks (solid and hollow type) | Compressive strength | > 5.0 kg/cm ² (0.5 Mpa) | 73.1 kg/cm ² (7.31 Mpa) |
| V-3.5 | IS 2185 (Part 2):1984 | Hollow load bearing light weight concrete blocks | Compressive strength (after 28 days) Grade B Water absorption | Upto 50 kg/cm ² (5.0 Mpa) < 10% | 73.1 kg/cm ² (7.31 Mpa) < 2% |
| V-3.6 | IS 3620:1979 | Laterite stone blocks for masonry | Compressive strength Water absorption | > 35 kg/cm ² (3.5 Mpa) < 12% | 73.1 kg/cm ² (7.31 Mpa) < 2% |
| V-3.7 | IS 3952:1988 | Burnt clay hollow blocks for walls and partitions | Min av. Crushing strength Water absorption | > 35 kg/cm ² < 20% | 73.1 kg/cm ² (7.31 Mpa) < 2% |
| V-3.8 | IS 2185 (Part 3):1984 | Autoclaved cellular concrete blocks | Density 851-1000 kg/m ³ | Compressive strength Grade-1 Grade-2 70kg/cm ² 60kg/cm ² | Net Dnsty Comp strgth 1140kg/cm ³ 73.1kg/cm ³ |

Note 1 : With concrete infill (combined with embedded concrete) value / strength of the panel is higher (see test results in Annex V-2)

Note 2 : These values are based on tests on blocks of size 300 x 300 x 120 mm (see para Annex V-2.2.1)

Annex V-4

Abbreviations

| | | |
|-------|---|---|
| BMBA | - | Board of Agreement of BMTPC |
| BMTPC | - | Building Materials and Technology Promotion Council |
| 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 Urban Development and Poverty Alleviation to serve as an apex body to provide interdisciplinary 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 informed choice.

In order to help the user in this regard to make informed choice and derive the envisaged social and economic benefits from the new developments the Ministry of Urban Development and 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 in information to the user to make informed choice.

To make the PACS transparent and authentic it is administered through a Technical Assessment Committee (TAC) 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. I-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. Feedback from users is welcome and will be useful in improving the products and technologies.

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

In case you have any suggestions/complaints write to:

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(under the ministry of Urban Development & Poverty Alleviation,
Government of India)
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4th cover page