A city like Ghaziabad, with ceaselessly growing industries and population, tends to strive people towards fresh air to breathe and healthy surroundings to live in.

The increasing need of green buildings and sustainability is becoming the thirst of these surroundings. Design solutions of buildings thus ask for functionality and occupant comfort, and with increasing importance, the comfort of our planet emits. With this we get envisaged with the fact of not just self, but also the world’s solace.

Accounting for all culpable factors, we are here to present you with the design of a GES building which adheres to a multitude of green management strategies. An adaptable surroundings working with renewability, efficiency and security, while taking a step forward towards sustainable well-being.
Site Infographic

LOCATION: 28.6795 N 77.4588 E
ALTITUDE: 214 M
LOCATED 50 KILOMETERS FROM DELHI

CLIMATIC ANALYSIS
CLIMATE TYPE: COMPOSITE
ANNUAL RAINFALL: 764 MM
AVERAGE HUMIDITY: 68%
SEISMIC ZONE IV
AIR QUALITY: VERY POOR
GROUND WATER LEVEL: 18.7 M IN 2016, PRE MONSOON LEVEL, DROPPED TO 30.6 IN 2020

ACCESSIBILITY
JHANSI RANI MARG
BUS STOP IN 500 M
SUBWAY IN 5.4KM

AIR QUALITY INDEX HISTORY
DECEMBER 2021: 335
DECEMBER 2020: 419
DECEMBER 2019: 412

AIR POLLUTION DUE TO NEARBY INDUSTRIAL ZONE
ADJACENT ROAD CAUSES NOISE & AIR POLLUTION

THE SITE RECEIVES GOOD SOLAR INSOLATION
ABSENCE OF WIND OR SUN BARRIERS IN CLOSE VICINITY
NEIGHBOURING VACANT LAND FOR FUTURE EXPANSION

THE SITE FALLS UNDER SEISMIC ZONE IV

PROPOSED DESIGN
GOVERNMENT OFFICES
ROADWAYS
NEARBY STRUCTURES

INDO SARACENIC ARCHITECTURE INFLUENCE
STEEL CHEMICAL SUGAR MILLS ELECTRONICS

MAJOR SEISMIC HISTORY OF GHAZIABAD
1945 6.5 RICHTER 273 KMS AWAY
1945 6.4 RICHTER 403 KMS AWAY
1955 6.2 RICHTER 316 KMS AWAY
1968 7 RICHTER 403 KMS AWAY
1966 8 RICHTER 403 KMS AWAY
1975 6.0 RICHTER 316 KMS AWAY
1975 6.8 RICHTER 316 KMS AWAY
1991 8 RICHTER 378 KMS AWAY
1999 8 RICHTER 426 KMS AWAY

CLOSERY LOCATED TO OTHER GOVERNMENT OFFICES
NO NOISE SOURCES ON 3 SIDES
AMPLE PRE-EXISTING VEGETATION & GREEN BUFFER IN SITE SURROUNDING
LOCATED ADJACENT TO A MAJOR HIGHWAY IN THE CITY CENTER

NEEM JAMUN GUAVA ASHOK MANGO CHAMPA BARBOLO BANYAN ARJUN KADAMBA MAHLA TAMARIND ALMALTAS

GRIHA TROPHY 2021-2022
64GRI-47
WE AIMED TO CREATE A BUILDING THAT IS A RESPECTFUL SUCCESSOR AND A NOTE-WORTHY PREDECESSOR TO A LONG LINE OF INDELIBLE MONUMENTS THAT HAVE HOUSED PRESTIGIOUS GOVERNMENT ESTABLISHMENTS.

A BUILDING THAT STANDS STRONG THROUGH DECADES OF SEISMIC ACTIVITY AND CHANGING GOVERNANCE WHILE DOING NO HARM TO THE ENVIRONMENT THAT SUSTAINS IT.

OUR DESIGN EVOLVED FROM THE BASIC VERNACULAR TYPOLOGY OF A COURTYARD EDIFICE INTO A MULTI-BLOCK BRIDGED COMPLEX WITH A COLOSSAL FACADE.

WE SET OUR SIGHTS AT CREATING A FACILITY THAT WAS SECURE FROM THREATS YET WELCOMING TO ITS EMPLOYEES. THE BUILDING TARGETS TO FUEL PRODUCTIVITY AND PROVIDE AN ATMOSPHERE OF RESPONSIBILITY AS WELL AS A SENSE OF COMFORT AND BELONGING.

INSPIRED BY EXPERIENCE DEVELOPERS, OUR TEAM INTENDED TO CREATE A FOUNDATION THAT IS PENSIVE IN GIVING OPEN ACCESSIBLE SPACES WHICH FOCUS ON INTERACTIONS BETWEEN NATURAL AND BUILT ENVIRONMENT. OUR APPROACH WAS TOWARDS BUILDING A FOLIAGE OF INSEPERABLE BONDS OF HEALTHY RELATIONSHIPS THROUGH POSITIVE LIVING.

**Outlook**

**Fins**

**Jaali**

**Colonnade**

**Arcade**

---

**DESIGN GOALS**

**SEISMIC STABILITY**

IMPORTANT FOR THE LONGEVITY OF THE EDIFICE.

**SENSORY INDULGEMENT**

THE DESIGN AIMS AT PROVIDING CHANGING STIMULI TO PREVENT MONOTONY.

**USER WELLNESS**

THE FACILITY ATTEMPTS AT A NEW-AGE GREEN GOVERNMENT OFFICE.

**BIOPHILIA**

DRAWING FROM AFFINITY OF HUMAN BEINGS WITH NATURE.

**PRIVACY & SECURITY**

FOCUS ON COST APPROPRIATE SECURITY TO BE LAID AT EVERY STAGE.

---

**USE OF THE CONVENTIONAL COURTYARD TYPOLOGY IN LIGHT OF THE COMPOSITE CLIMATE.**

**STAGGERATION BETWEEN FLOORS TO ALLOW FOR SELF-SHADING.**

**CONVERSION TO RECTANGULAR BLOCKS & ADDITION OF STRUCTURAL FRAMEWORK FOR SEISMIC STABILITY.**

**ADDITION OF BRIDGES FOR CONNECTIVITY BETWEEN BLOCKS. THESE BRIDGES HAVE THEIR INDIVIDUAL FRAMEWORK. ALL BLOCKS ARE CONNECTED BY EXPANSION JOINTS.**

---

**Aspirations and Evolution**

GRIHA TROPHY 2021-2022
Plans and Sections

DIVISION FLOOR LEGEND

<table>
<thead>
<tr>
<th>ROOMS</th>
<th>AREAS IN m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. FUTURE EXPANSION</td>
<td>63</td>
</tr>
<tr>
<td>1. EAS ROOM</td>
<td>40</td>
</tr>
<tr>
<td>2. INSPECTOR ROOM</td>
<td>27</td>
</tr>
<tr>
<td>3. SUPERINTENDENT ROOM</td>
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</tr>
<tr>
<td>4. ENTRANCE</td>
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<tr>
<td>5. A.J.H.</td>
<td>33</td>
</tr>
<tr>
<td>6. PANTRY</td>
<td>18</td>
</tr>
<tr>
<td>7. AUDIT ROOM</td>
<td>28</td>
</tr>
<tr>
<td>8. VIGILANCE</td>
<td>22</td>
</tr>
<tr>
<td>9. WAITING ROOM</td>
<td>25</td>
</tr>
<tr>
<td>10. STORE ROOM</td>
<td>28</td>
</tr>
<tr>
<td>11. RECORD ROOM</td>
<td>28</td>
</tr>
<tr>
<td>12. LEGAL REVIEW &amp; ADJUDICATION</td>
<td>44</td>
</tr>
<tr>
<td>13. DIVISION ROOM</td>
<td>128</td>
</tr>
<tr>
<td>14. TOILET BLOCK</td>
<td>60</td>
</tr>
<tr>
<td>15. INTERROGATION</td>
<td>28</td>
</tr>
<tr>
<td>16. MINI CONFERENCE</td>
<td>32</td>
</tr>
<tr>
<td>17. CHIEF COMMISSIONER ROOM</td>
<td>40</td>
</tr>
<tr>
<td>18. DEPUTY COMMISSIONER ROOM</td>
<td>44</td>
</tr>
<tr>
<td>19. ADDITIONAL ROOM</td>
<td>22</td>
</tr>
<tr>
<td>20. EMPLOYEES' LOUNGE</td>
<td>90</td>
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GENERAL FLOOR LEGEND

<table>
<thead>
<tr>
<th>ROOMS</th>
<th>AREAS IN m²</th>
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<tbody>
<tr>
<td>A. PAY AND ACCOUNTS OFFICE</td>
<td>50</td>
</tr>
<tr>
<td>B. STAFF ASSOCIATION</td>
<td>76</td>
</tr>
<tr>
<td>C. ATRIUM</td>
<td>94</td>
</tr>
<tr>
<td>D. CANTEEN &amp; DINING</td>
<td>127</td>
</tr>
<tr>
<td>E. EMPLOYEE'S LOUNGE</td>
<td>65</td>
</tr>
<tr>
<td>F. TOILET BLOCK</td>
<td>39</td>
</tr>
<tr>
<td>G. ACCOUNTS</td>
<td>47</td>
</tr>
<tr>
<td>H. ELECTRICAL TRANSMISSION</td>
<td>35</td>
</tr>
</tbody>
</table>
OPEN LOUNGES LOCATED ON ALL THE BRIDGES, INTERTWINING THE EXTERIORS WITH THE INTERIOR LEISURE SPACES, FOR EMPLOYEE WELFARE.

AN ATRIUM OVER THE ENTRANCE LOBBY CREATES VARIATION IN VOLUME, LIGHT & AIR, AND A FEELING OF GRANDEUR.

THE NORTH BRIDGE FEATURES A WATER CURTAIN THAT ACTS AS A COOLANT & A PURIFIER FOR INCOMING WIND INTO THE COURTYARD.

EXCAVATION OF THE BASEMENT BEYOND BUILDING SURFACE OPENS IT UP TO THE NATURAL ELEMENTS, WITH A VIEW OF THE COURTYARD.

Views and Sights
Design Strategies

**Water Demand Management**

- In flush tank basins, when the sink is used for hand washing, gravity brings the water into the toilet tank for the next use.
- Flush tanks fitted with dual flush mechanism. This saves up to 75% water demand.
- Refilling toilets use perforated pipe and cleansing mechanism to reuse black water to a small extent.
- Waterless urinals use density variations in water and oil to avoid flushing; they are odorless and maintenance free.
- Low flow fixtures use aerators that cut back on water demand by 75-80%.

**Rainwater Management**

- Tensile roofs over pathways collect rainwater through gutters to be stored in a reservoir.
- Impermeable site surfaces have been sloped towards rainwater gardens to prevent undirected runoff.
- Pebble drains filter the sediments, organic matter and oil residue from the runoff. Runoff rate is reduced and it also acts as runoff storage.
- Onsite rainwater gardens at regular intervals prevent runoff and serve as a good system for ground-water recharge; strategy extremely important for this site.

**RHINO BRICKS (PLASTIC BRICK) FOR MAN-SONRY ENTAILS:--**

- Extremely low water consumed in production
- Negligible water is required for curing
- 75% of foundry dust constituent is recyclable after demolition
- 2.5 times stronger & 25% lighter than regular bricks, making them suitable for seismic stability

**Concrete Paving on the Site Has Blocks Made with 20% C&D Waste**

**Plastic Bricks Used for Construction Are Made with 25% Plastic & 75% Foundry Dust**

**Coniferous Green Cover Onsite**

- 69% of green cover onsite
- 22% of low surfaces
- Green roofing to minimize heat island effect allows for comfortable occupancy & to increase green cover.

**Gypsum Boards Have Been Used in Interior Finishes**

**Air Curtains on All Entry Points**

To control air quality absorbing planters along site roads feature an exhaust for emissions.

**Rounded Edges**

- Exterior walls have been finished with limestone cladding

**9.8% of High Cover**

**GRIHA Trophy 2021-2022**

**64GRI-47**
Design Strategies

Solar panels are an attempt at self-reliance & reduce dependence on conventional energy systems.

Photovoltaic glass on south-facing clerestory and over the atrium cutout windows makes good use of incident radiation.

Braille script on all railings to allow for comfortable navigation of differently abled users.

All staircase towers have skylights with photovoltaic glass that only allows incident visible light.

Horizontal fins ascend in protrusion as the floor level increases to suit varying incident radiation.

Variations in flooring textures assist differently abled users in navigating through the site.

Movable FRP fins on south and southwest facing facades to allow autonomy over sunlight admission in winters & summers.

Organic waste management:

On-site composting for organic matter enriches soil and reduces the need for chemical fertilizers.

Majority of on-site solid waste comprises of refuse and leftovers from the canteen & pantries, along with landscaping waste produced in indoor & outdoor gardens.

Piezoelectric systems have been used on the speed breakers on vehicular ramps to utilize break impact of vehicles. This power can be used for the street lighting.

An excavated basement space runs beside the central courtyard. This space is a connector of basement with nature.

Air ventilators and glass skylights have been incorporated into the design to allow daylight and fresh air into the basements.

Landscaping by alternate placement of plants with varying root depth ensures optimum nourishment for every plant. Hence, full growth is achieved.
DAYLIGHT ILLUMINANCE

Optimum illuminance for office working spaces has been achieved throughout the daytime. This ensures visual comfort for adequate productivity.

The useful daylight illuminance without artificial lighting ranges from 120 lux to >300 lux.

Daylight illuminance simulations were performed on Autodesk Revit.

MORE THAN HALF OF THE COURTYARD REMAINS SHADED THROUGHOUT THE DAY.
13 MAY 2021 09:15 A.M.

SADH ANALYSIS

13 MAY 2021 04:15 P.M.

Wind analysis simulations were performed on Autodesk CFD.

SOLAR ANALYSIS

As a result of facade treatment and climate-aware orientation, we see a 19.65% decrease in cumulative insolation received by the building.

As a consequence of this, indoor temperatures of the building are reduced.

SOLAR ANALYSIS - Simulations were performed on Autodesk Revit.

SOUTHWEST VIEW

SOUTHEAST VIEW

SUN STUDY SPAN
01-01-2010 TO 31-12-2010
CUMULATIVE INSOLATION

SOLAR ANALYSIS WITH FACADE TREATMENT
CUMULATIVE INSOLATION - 511 kWh/m²

SOLAR ANALYSIS WITHOUT FACADE TREATMENT
CUMULATIVE INSOLATION - 636 kWh/m²

WIND ANALYSIS

Due to the prevailing wind direction, we see the wind entering the courtyard through the north bridge and being directed towards the rest of the building.

Wind analysis simulations were performed on Autodesk CFD.

Building Simulations

GRIHA TROPHY 2021-2022
1. GOAL: THE GOAL OF THE STUDY THAT IS DESCRIBED IN THIS ANALYSIS IS TO DETERMINE THE MAIN ENVIRONMENTAL IMPACT OF THE BUILDING, WITH A FOCUS ON THE BUILDING'S CONSTRUCTION AND TECHNICAL INSTALLATIONS.

2. SCOPE: THE ANALYSIS ACCOUNTS FOR THE FULL CRADLE TO GRAVE LIFE CYCLE OF THE DESIGN OPTIONS STUDIED ACROSS ALL LIFE CYCLE STAGES, INCLUDING MATERIAL MANUFACTURING, MAINTENANCE AND REPLACEMENT, AND EVENTUAL END OF LIFE.

2A. FUNCTIONAL UNIT: A BUILDING IS A MULTI-FUNCTIONAL ITEM AND MANY OF ITS FUNCTIONS ARE IN REGULATED BUILDING CODES. TO MINIMISE ENVIRONMENTAL IMPACT WHILE CONSTRUCTING THE BUILDING, BUILDING CODES ARE COMPLIED TO. THE TIME FRAME OF 60 YEARS WAS CHOSEN.


2C. EXCLUDED LIFE CYCLE STAGES: THE LIFE CYCLE STAGES A5, B1, B6, B7 AND C1 WAS EXCLUDED.


3A. DATA SOURCE: LCA MODELING WAS CONDUCTED IN GABI 8.5 USING GABI 2018 DATABASES AND IN ACCORDANCE WITH GABI DATABASES AND MODELING PRINCIPLES.

3B. DATA QUALITY AND UNCERTAINTY: THE GABI LCI DATABASES HAVE BEEN USED IN LCA MODELS WORLDWIDE IN BOTH INDUSTRIAL AND SCIENTIFIC APPLICATIONS. THESE LCI DATABASES HAVE ADDITIONALLY BEEN USED BOTH AS INTERNAL AND CRITICALLY REVIEWED AND PUBLISHED STUDIES. UNCERTAINTY INTRODUCED BY THE USE OF PROXY DATA IS REDUCED BY USING TECHNOLOGICALLY, GEOGRAPHICALLY, AND/OR TEMPORALLY SIMILAR DATA.

3C. ENVIRONMENTAL IMPACT CATEGORIES: POTENTIAL IMPACTS ARE REPORTED IN KILOGRAMS OF EQUIVALENT RELATIVE CONTRIBUTION (EQ) OF AN EMISSION COMMONLY ASSOCIATED WITH THAT FORM OF ENVIRONMENTAL IMPACT.

- Acidification Potential (AP) KG SO2EQ
- Eutrophication Potential (EP) KG NEQ
- Global Warming Potential (GWP) KG CO2EQ
- Ozone Depletion Potential (ODP) KG CFC-11EQ
- SMOG Formation Potential (SFP) KG O3EQ
- Primary Energy (MJ)
- Renewable Energy (MJ)


GRIHA TROPHY 2021-2022
4. LIFE CYCLE IMPACT ASSESSMENT (TABLE A)

<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACT TOTALS</th>
<th>PRODUCT</th>
<th>CONSTRUCTION</th>
<th>USE</th>
<th>END OF LIFE</th>
<th>MODULE D</th>
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</thead>
<tbody>
<tr>
<td>GLOBAL WARMING (KG CO₂-EQ)</td>
<td>13,09392</td>
<td>16,006</td>
<td>89,190</td>
<td>19,105</td>
<td>-4,27160</td>
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<tr>
<td>ACIDIFICATION (KG SO₂-EQ)</td>
<td>5,809</td>
<td>74,17</td>
<td>629,3</td>
<td>87,43</td>
<td>-2,780</td>
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<tr>
<td>EUTROPHICATION (KG N-EQ)</td>
<td>150,9</td>
<td>6,039</td>
<td>27,16</td>
<td>4,434</td>
<td>-44,7</td>
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<tr>
<td>SMOG FORMATION (KG O₃-EQ)</td>
<td>56,837</td>
<td>2,451</td>
<td>7,449</td>
<td>1,739</td>
<td>-21,350</td>
</tr>
<tr>
<td>OZONE DEPLETION (KG CFC-11EQ)</td>
<td>-3,3076E+05</td>
<td>5,482E-010</td>
<td>2,922E-006</td>
<td>3,479E-009</td>
<td>3,040E-005</td>
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<tr>
<td>PRIMARY ENERGY (M3)</td>
<td>1,798E+007</td>
<td>2,32,762</td>
<td>13,32,353</td>
<td>3,24,004</td>
<td>-65,18,944</td>
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<tr>
<td>NON-RENEWABLE ENERGY (M3)</td>
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<td>11,72,864</td>
<td>3,02,961</td>
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<td>RENEWABLE ENERGY (M3)</td>
<td>4,42,822</td>
<td>5,629</td>
<td>1,55,148</td>
<td>21,403</td>
<td>-24,87,491</td>
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</tbody>
</table>

5. LIFE CYCLE INTERPRETATION

5a. THE PRODUCTION OF BUILDING PRODUCTS; (A1–A3) LIFE CYCLE PHASES WITH THE DOMINANT IMPACTS.
5b. BUILDING OPERATION; (B2 – B5) SMALL YET SIGNIFICANT IMPACT
5c. TRANSPORTATION AND END OF LIFE; (A4, C2 – C4) HAVE NEGligible ENVIRONMENTAL IMPACT
5d. MODULE D: (D) HAS RESULTED IN REDUCTION OF -
GWP BY 30 %
AP BY 42 %
EP BY 24 %
SFP BY 31 %
LOWER HEATING VALUE BY 26 %

Life Cycle Data
**Life Cycle Data**

**Energy Optimization**
- Optimization model created on Autodesk Revit

**Life Cycle Cost Analysis**
- Water demand has been reduced by 30.87% with a payback period of 4.88 years.
- Initial Stage 1 > Intermediate Stage 1 > Intermediate Stage 2 > Final Design
- Water demand comparison USD / m³/year: Initial Stage 1 > Intermediate Stage 1 > Intermediate Stage 2 > Final Design

**Water Demand Reduction**
- Usage: Original Demand (in litres) vs Reduced Demand (in litres)
  - WC: 1420 vs 0
  - Urinal: 950 vs 0
  - Wash Basin: 1720 vs 344
  - Canteen: 4500 vs 2250
  - Pantry: 300 vs 150
- Total: 6890 vs 2744

**Wastewater Treatment**
- Quantity of treated wastewater per day: 2,286 kilo litre
- Cost of wastewater treatment plant: 2,00,000 Rs
- Cost of treated wastewater per year: 40,992 Rs
- No. of years required to repay the cost: 4 years 7 months

**Renewable Energy Systems**
- Surface area m²: PV Glass 333, Solar Panels 3216, Kinetic Ramp 144, Total 3693
- Electrical energy produced kwh/yr: PV Glass 60,217, Solar Panels 7,416,777, Kinetic Ramp 51,2082, Total 8,21,945.21
- Per yr savings in Rs: PV Glass 12,033, Solar Panels 1,11,252, Kinetic Ramp 768, Total 1,24,053

**Rainwater Management**
- Annual rainfall: 764 millimeters
- Total site area: 8959.1 square meters
- Harvesting potential: 6844.75 cubic meters
- Harvested water: 2889.77 cubic meters
- Groundwater recharge: 3954.98 cubic meters

**GRIHA Trophy 2021-2022**
SUSTAINABLE SITE PLANNING
CRITERION 1: GREEN INFRASTRUCTURE
CRITERION 2: LOW IMPACT DESIGN STRATEGIES
CRITERION 3: DESIGN TO MITIGATE HAZARD
CONSTRUCTION MANAGEMENT
CRITERION 4: AIR AND SOIL POLLUTION CONTROL
CRITERION 5: TOPSOIL PRESERVATION
CRITERION 6: CONSTRUCTION MANAGEMENT PRACTICES
ENERGY OPTIMIZATION
CRITERION 7: ENERGY OPTIMIZATION
CRITERION 8: RENEWABLE ENERGY UTILIZATION
CRITERION 9: LOW CO2P AND GWG MATERIALS
OCCUPANT COMFORT
CRITERION 10: VISUAL COMFORT
CRITERION 11: THERMAL AND ACOUSTIC COMFORT
CRITERION 12: NATURAL QUALITY
WATER MANAGEMENT
CRITERION 13: WATER DEMAND REDUCTION
CRITERION 14: WASTE WATER TREATMENT
CRITERION 15: WATER MANAGEMENT
CRITERION 16: WATER QUALITY AND SELF-SUFFICIENCY
SOLID WASTE MANAGEMENT
CRITERION 17: WASTE MANAGEMENT POST OCCUPANCY
CRITERION 18: WASTE TREATMENT ON SITE
CRITERION 19: RECYCLABLE MATERIALS
CRITERION 20: OPTIMIZATION OF ALTERNATIVE MATERIALS IN BUILDING
CRITERION 21: REUSING IN CAMP THROUGH LIFE CYCLE ASSESSMENT
CRITERION 22: INTEGRATED MATERIALS FOR EXTERNAL SITE DEVELOPMENT
SOCIO-ECONOMIC STRATEGIES
CRITERION 23: SAFETY AND SANITATION FOR CONSTRUCTION WORKERS
CRITERION 24: UNIVERSAL ACCESSIBILITY
CRITERION 25: DEDICATED FACILITIES FOR SERVICE STAFF
CRITERION 26: POSITIVE SOCIAL IMPACT
PERFORMANCE METERING AND MONITORING
CRITERION 27: COMMISSIONING FOR FINAL RATING
CRITERION 28: SMART METERING AND MONITORING
CRITERION 29: OPERATION AND MAINTENANCE PROTOCOL
INNOVATION
CRITERION 30: INNOVATION

Fin.