GRIHA-RATING FOR UPES G&H BLOCK

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GRIHA-RATING FOR UPES G&H BLOCK

A thesis submitted in partial fulfilment of the requirements for the Degree of

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CERTIFICATE

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DECLARATION

This is to hereby state with the intention of this report is very original in every sense of the terms and conditions and it carries a sense of honour and belief and that no shortcuts have been taken and I remained both meticulous and caring during the prevalence of this research work. I have put in my best to keep this work as informative and precise as possible.

It may be also stated here that during the preparation of this report some help has been taken from a scope of professionally shared information & knowledge, a comprehensive description of which has been mentioned in the references chapter of this report.

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ABSTRACT

No one disputes the advantages of a sustainable building design. Green buildings use less water and energy, emits fewer emissions & have lower operations & maintenance costs. They use relatively fewer natural resources during their construction & have higher property values. And employees who work in these sustainably designed facilities are, on average, healthier and more productive as per a report cited by PWC dated 17th October'11.

These aren't just "feel-good" facts but are also of demonstrable benefits. For example, a study conducted by the Mumbai Water Corporation found that green buildings could effectively put a check on water usage by 23 percent. These are results that also translate directly to long-term savings. There's still a fair amount of resistance to the implementation of sustainable building designs because of the age old perception that it's too expensive as compared to the typical buildings. Most initial reports, however, indicate that fears of extra expense are largely unfounded. Many studies & reports reveal that the cost of implementing a moderate level of green design ranges from about 1 to 2 percent higher than the typical building costs.

There is little doubt, however, that a minimal investment can yield such high substantial returns. There are reports that also confirms—**minimal increases in upfront costs of about 2 percent would, on average, result in life cycle savings of 20 percent of total construction costs—more than 10 times the initial investment.**

"….. Environmentally sustainable building, designed, constructed and operated to minimize the total environmental impacts."

-Build Green

This Thesis provides an insight of the actual works encountered during construction of a green Building, taking into account the experiences gained during the construction of G & H Block of University of Petroleum & Energy Studies, Dehradun.

Literature Review

"...a building that integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity."

-Energy Policy Act of 2005

Many works have been done on various aspects and impacts of green Building. A brief review of literature is carried out as under for a clear understanding of the topic.

A recent survey conducted by U.S. Green Building Council shows that many of its members believe that the sustainable building design will become a more common practice once the human benefits are identified, primarily the productivity gains believed to be associated with the provision of high quality interior environments **(USGBC, 1999).**

A number of case studies & articles show a very strong positive correlation between the work performance of employees & the building in which the process takes place. For instance, **Romm and Browning (1998)** reported eight case studies that show up to a 17% improvement in productivity between the employees in existing facilities and the employees in re-modeled or new facilities designed according to green building principles.

Heerwagen(2001) found significant productivity gains in these sustainable designed buildings and reported that the workers' "overall [positive] feeling about the environment" increased by up-to 60 percent. Literature also suggests the cognizance & discussion of the economic & environmental impacts of building over design, specification and use of contingency margins is not new but has been with us for some decades **(Lovins, 1992; Sorrell 2001; Romm & Browing, 1998).**

Bordass (2000) suggests that this collective amnesia′ is simply the property industry's' mechanism to resist change. Clearly there must be some truth to the notion.

"One that uses less water, optimizes energy efficiency, conserves natural resources, generates less waste, and provides healthier spaces for occupants"

-Indian Green Building Council

CHAPTER 1| INTRODUCTION

1.0 Green buildings: global and local perspective

The construction sector poses a major challenge or in some sense threat to the environment. Globally, typical non sustainable buildings are responsible for at least 43% of energy use as per reports cited by American energy agency. An estimated 42% of the global water consumption and 51% of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, & operational period of buildings. In addition, building activities also contribute an estimated of around 52% of the world's air pollution, 43% of its greenhouse gases, 51% of water pollution, 49% of all solid wastes and 53% of all CFCs (chlorofluorocarbons) to the environment.

India too faces the environmental challenges in the domain of construction sector. The gross built-up area that has been added to commercial and residential spaces was about 41.8 million square metres in 2011–12, which is about 1.2% of annual average constructed floor area around the globe & the trends also highlight on the sustained growth of about 11% over the coming years. With a near consistent 9% rise in annual energy consumption in the residential and the commercial sectors, building energy consumption has seen an increment; from a low of 14% in the 1970s to nearly 42% in 2011–12. Energy consumption would continue to rise un-interrupted unless suitable actions to improve energy efficiency are brought up & implemented without delay. As per the estimates of TERI, there is an incremental demand of about 5.4 billion units (kWh) of electricity annually for meeting the end-use energy requirement in both residential and commercial buildings.

Buildings remain heavy consumers of water during construction as well as during their operation (for cooling, occupants and landscaping). As per the reports per capita water consumption in 1990 was about 2463 m^3per capita per annum, but by 2030 with an expected population of 1.42 billion, it will almost certainly be in the stressed category with less than 1800 m^3 per capita per annum. In terms of the handiness to water supply, as per the data conceived from the State Governments of India, as of March 2012, about 92% of urban population has access to drinking water supply facilities. The covered figures indicate only the accessibility, whereas equitable adequacy & distribution and per-capita provision of these basic animities may not be as per the prescribed norms in some cases. For example, the lower middle class or the under privileged segment, particularly those living in slums & squatter settlements, are generally deprived of such basic facilities. Similarly, the issue of water supply is critical not only for day to day needs of drinking water but also an important parameter for agriculture and allied activities.

While we clamber with water shortage, there remains a huge hidden potential of meeting the resource gap through the treatment of waste water & reuse of the same for various applications. As per an appraisal made by the Central Pollution Control Board (CPCB) on the position of wastewater generation & treatment in Tier I cities and Tier II towns during 2011–12, about 26,254 million litres per day (MLD) (9.51 billion cubic metre (BCM) was generated in 921 Tier I cities and Tier II cities in India (housing more than 70% of urban population). The waste water handling capacity developed so far is about 7044 MLD accounting for only 27% of waste water generated in these two classes of urban centres (2.57 BCM/year).

Handling of construction & demolition waste and solid waste generated by residents of building pose another major challenge which needs undivided attention. The CPCB, by their various studies has estimated current quantity of solid waste generation in India to the level of about 48 million tonnes per annum, out of which 26% of waste accounts only form construction industry. Management of high these quantities of wastes puts enormous burden on solid waste management system. In accession, about 44 million metric tonnes (MMT) of solid waste is being generated daily in the urban areas of the country as of the present scenario. Most of the urban centres lack appropriate management, segregation as well as treatment facilities for solid wastes. Currently, municipal solid waste is rarely filtered at source. Mixed waste is being continuously dumped without any check into the pits/depression or earmarked low lying areas in and around the towns. Municipal solid waste comprises of about 30% to 55% of bio-degradable (organic) matter, 20% to 35% inert matter and 5% to 15% recyclables. The organic fraction from the municipal solid waste contains bio-degradable matter ranging from 30% to 55%, which can be profitably converted into useful products like compost (organic manure), methane gas (used for heating, cooking, production of energy & lighting), and so on. And this has been taken up by various companies globally.

At macro level, large scale urbanization is contributing to uncontrolled 'heat island' effect. Vegetation and tree covers give way to citified areas with large instances of pavements, buildings, & other structures, thus wiping out cooling provided by vegetation through both shade & evaporation & also transpiration. This also contributes to the formation of ground-level ozone, which is substantial to human health. Urban heat island impacts create opportunities to an increased temperature that may up to be up-to ten degrees Fahrenheit. This in turn also results in increased demand for air conditioning. Which in turn leads to an incremental air conditioning demands increased generation of electricity/power which again contributes to the emission of greenhouse gases at the end. These need to be addressed at settlement planning level as well as on the micro planning level during site development as well as during the planning for buildings.

As we move on our progress path, it is important for us to keep a keen watch on the environmental damages that we may create knowingly or unknowingly. It thus becomes extremely important to pause for an instance & carry out necessary course correction for benefit of the global Earth and our also for the future generations. It is a well-established fact that green buildings offer immense potential of reducing consumption and regeneration of resources from waste & renewable sources and thus offer a win-win solution for the user, owner and as well as for the environment.

1.1 What is a green building?

Buildings have major environmental impacts all throughout their life cycle. Resources such as forests, ground covering, energy & water are being crushed to give way to buildings. Resource-intensive materials provide a structure to the building, whereas the landscaping beautifies it, at the expense of usage of water and pesticides to maintain it. Energy-consuming systems for air conditioning, lighting & water heating provide comfort to its residents. Hi-tech controls adds tidings to 'inanimate' buildings so that they can respond to diverging conditions around, & at the same time intelligently monitor and control the resource use, its security, & usage of fire fighting systems and other such systems in the building concerned. Water, another vital resource for its residents, gets devoured continuously during the construction and operation of a building. Various building processes and its resident functions generate large heaps of waste, which can be either reused directly without processing or can be recycled for use. Buildings are thus in one or the other sense one of the major pollutants that directly or indirectly affects urban air-quality and contribute to climate change. Hence, the motivation to design a green building, the motto of which is to address all these issues as stated above in a scientific, integrated & planned manner. It is a very oblivious fact that it costs more to design as well as construct a green building as compared to other non typical non green buildings.

However, it is also a proven fact that it costs less to maintain a green building that has enormous environmental benefits and also provides a better place for its residents to live & work in. Thus, the basic challenge of a green building lies in to achieving all its benefits & that too at an affordable cost so that it could justify its creations & existence.

A green building uses the natural resources to a minimum possible level during its construction & maintenance & operation. The aim of a green building design is to minimize the demand on the depleting non-renewable resources, and on the contrary laying emphasis on maximizing the utilization efficiency of these resources when in use, and maximize the reuse, recycling, and utilization of renewable resources. Green Building maximizes the use of efficient basic building materials which low in embodied energy and also in construction practices; optimizes the usage of on-site sources and sinks by bioclimatic architectural practices; uses minimum external energy to power itself; lays emphasis on usage of efficient equipment to meet its air conditioning, lighting, and other needs; maximizes the usage of renewable sources of energy; usage of an efficient waste & water management practices; and also provide comfortable and hygienic indoor working conditions. It has developed through a design process that has taken input from all concerned – including the architect; landscape designer; and the air conditioning, plumbing, electrical, & energy consultants – to work as a team to address various aspects of building and system planning, construction, designing, and operation. Then captiously evaluating the impacts of each design decision and finally arriving at viable design solutions to minimize the negative impacts and thus enhancing the positive impacts on the environment around.

In sum, the following aspects of a green building design are being looked into in an integrated way:

- ✓ Site planning
- ✓ Building system design (HVAC [heating ventilation & air conditioning],water heating, lighting, & electrical)
- ✓ Building overall design
- ✓ Integration of various renewable sources to generate consumable energy on-site
- ✓ Selection of ecologically sustainable low embodied energy materials (with rapidly regenerated renewable resources, high recycled content, with low emission potential, & so on)
- ✓ Indoor environmental quality (indoor thermal and visual comfort and air quality)
- ✓ Water and waste management

1.1.1 *Benefits of green building*

A sustainable green building has lower resource consumption as compared to conventional buildings. The following are the percentage reduction of various resources in a building and their respective reasons as per various previous studies done globally, explained.

- Green buildings consumes about 45% to 65% (depending on the array of measures adopted) lesser power as compared to typical non-green buildings. This lesser consumption is mainly because these buildings rely on the passive architectural intercessions in the building design, & usage of high efficiency materials and technologies in the engineering design of the building.
- Green Buildings also aims to heavily work towards on-site energy generation through renewable energy (solar/wind/hydro) utilization to cater to its own energy needs. For example, solar based thermal systems can aid in generation of hot-water & thus replacing the conventional electrical geyser in buildings concerned. Solar PV panels can also assist in generation of electricity which can in turn cut down the buildings dependence on the grid power.
- Green buildings consume about 50% to 75% (depending on the array of measures adopted) lesser water as compared to a typical conventional buildings. By the implementation of dual plumbing systems, rain-water harvesting, waste-water recycling systems, & ultra-low-flowing fixtures; green buildings not only reduce their requirement for water usage but also look at on-site supply options to supply to its internal as well as external (landscape) water needs.
- Green buildings yield lesser waste by employing various waste management strategies on-site. They may also move to implement waste to energy or waste to resource (like compost or manure) strategies on site, to further bring down their burden on municipal waste management facilities and land-fills.
- Green buildings render lesser pollution both during its construction as well as during its operations & maintenance. Through implementation of certain best-practices such as proper storage & disposal of waste during construction and operation, barricading of the site up-to 3m (as stated under GRIHA norms) to prevent air pollution & noise pollution during its construction, proper storage of construction materials, and so on, assures a reduced affect on the surrounding environment.
- Green buildings also ensure proper health, safety, & sanitation facilities for tits labourers (during construction) and the residents (while in use).
- Green buildings puts a check on the use of high ozone depleting potential (ODP) substances in their systems as well as in finishes.
- And above all Green buildings offer higher marketability & image; in other term Market branding.

1.1.2 *What is green building rating system?*

A green building rating system is an evaluation tool that appraises environmental performance of a building throughout its life span. It generally comprises of a set of various criteria covering different parameters each related to the design, construction, operation & maintenance of a green building. Each criterion has some pre-assigned points and these sets performance benchmarks & goals that are largely quantifiable. A project is granted points only if it fulfils the stated rating criteria's as specified. The points scored are then added up &

then the final rating of the given project is decided. Rating systems call for independent third party evaluation of a project and different processes are put in place so as to ensure a transparent & fair evaluation. Globally, green building rating procedures/systems are largely voluntary in nature and have been instrumental in raising knowingness and popularizing green building designs.

1.2 Some of the successful international rating programmes

1.2.1 LEED

Leadership in Energy and Environmental Design (LEED) was developed in the US in 1998 as a consensus-based sustainable building rating system based on the usage of existing building technology; a comparison based study. LEED rating system addresses various specific environmental building related affect keeping in view the whole building environmental performance approach. The Indian Green Building Council has adapted LEED system at large and has launched LEED India version for rating of any new construction interested in. In addition to that, the Indian Green Building Council (IGBC) has also launched several other products/services for rating of different types of typologies of buildings those including factories & homes among others. The following listed below are some of the key components of the LEED system:

- Sustainable sites location (construction related various pollution prevention measures, site development after effects, , various transportation alternatives, waste water management, heat island effect & light pollution)
- Water efficiency measures (reduction in landscaping water use, various efficient waste water management strategies & indoor water use curbing methods)
- Resources & Materials (building reuse, construction waste management policies, purchase of regionally manufactured materials; thereby reducing the embodied energy content & recycling collection locations, salvaged materials, materials with recycled substances, rapidly renewable materials & usage of certified wood products by FSC or any other certifying agencies)
- atmosphere & Energy (commissioning, Entire building energy performance optimization, , measurement & verification, renewable energy use &refrigerant management)
- Indoor environmental/air quality (outdoor air delivery monitoring, construction indoor air quality, increased airing, environmental tobacco smoke control/ prohibition of tobacco products, usage of low emitting materials, better controllability of thermal and lighting systems & also source control)
- Design process & Innovation (innovative strategies for sustainable design & LEED accredited professional)

1.2.2 BREEAM

Building Research Establishment's Environmental Assessment Method (BREEAM) was conceived in the United Kingdom in the year 1990 and is one of the primitive sustainable building environmental assessment methods. BREEAM have a wide panorama of institution types including—offices, retail units, homes, industrial units & colleges. When a building is evaluated, grades are granted for each standards or criterions as laid down under it and then awarded points are added for a total score. The overall building functioning is awarded either a 'Pass', 'Good', 'Very Good' or 'Excellent' rating based on the marks it achieves during its certification process. BREEAM has separate checklist for both evaluation of the Design and Procurement and for the Management and Operation of buildings. There is also a set of core credits that can be soughted for, in case if the building wishes to enter for 'Core only' appraisal for building performance.

A BREEAM major category for Design and Procurement includes the following criteria:

- Management (energy usage in site activities, monitoring of commissioning of various appliances, commissioning period process followed, waste management techniques & pollution minimization techniques)
- Land use (previously used land, use of re mediated contaminated land)
- Health and comfort (adequate ventilation, humidification outlets, energy efficient lightings, lower noise levels, visual & thermal comfort & presence of controllable blinds as well)
- Ecology (methods maintaining major ecological systems on the land , or usage of land with lower ecological value or minimal alteration in & minimization of biodiversity affects)
- Energy (sub-metering)
- Water (in aspects of measurement, consumption reduction and leak detection)
- Materials (possible reuse of structures, use of crushed aggregate with lower embodied energy, asbestos mitigation (UK specific), specifications of envelope & sustainable timber used, proper storage facilities of materials,)
- Transport (alternative transportation facilities, modes of transportation to and from site); in similarity to LEED
- Pollution (on-site treatment, avoidance of usage of ozone depleting and global warming substances, various leak detection systems in place, usage of local or renewable energy sources & light pollution design)

1.2.3 CASBEE

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was developed in Japan, in 2001. This assessment tools was based on the building's life span: keep in view the existing buildings structure, pre-designing, renovation, new construction in process. CASBEE demonstrates a new concept for appraisal that distinguishes environmental load from building performances & environmental quality. Under CASBEE there are two domain, external and internal, both separated by the conjectural boundary, which are generally defined by the site limit & various other components, with two factors related to the specified two domains as above, in which the 'non positive aspects of environmental impact which go beyond the non existing enclosed domain to the outside (the public property)' and 'improving occupant amenity for the building users' are considered side by side. Under CASBEE, these two factors are examined below as Q and L, the main appraisal categories, and calculated separately.

Q (Quality): Building Environmental Quality and Performance

Emphasises on Evaluation of 'improvement in amenity for the occupants, within the hypothetical enclosed space as suggested (the private property)'.

L (Loadings): Building Environmental Loadings

Emphasizes on Evaluation of 'non positive aspects of environmental impact which generally go beyond the hypothetical enclosed domain to the outside (the public property)'.

By relating these two domains, CASBEE results are given as a measure of eco-efficiency or BEE (Building Environmental Efficiency). The resulting Outcomes are then plotted on a graph, with quality on one axis and environmental load on the other axis – the best buildings will fall in the section representing lowest environmental load & highest quality. Each criterion is scored from level 1 to level 5, with level 1 defined as meeting the minimum requirements, level 3 is justified as meeting typical technical & social levels at the time of the assessment, and level 5 representing a higher level of achievement.

CASBEE major categories include

Building Environmental Performance & Quality

- Indoor environment (thermal & visual comfort, noise & acoustics & indoor air quality)
- Quality of services (amenities, adaptability, durability & reliability, functionality & usability & flexibility)
- Outdoor environment on site (creation of biotope & preservation, local characteristic, townscape and landscape, and outdoor amenities)

Building Environmental Loadings

- Energy (efficient operations, utilization of natural energy, Building thermal load, efficiency in building service systems)
- Resources and materials (materials of less environmental loads, water conservation)
- Off-site environment (sunlight obstruction, load on local infrastructure, air pollution, noise & vibration, odour, light pollution & heat island effect)

1.2.4 HK–Beam

The Hong Kong Building Environmental Assessment Method (HK-BEAM) is a voluntary schemefirst launched in December 1996 HK–BEAM is a performance based system that takes holistic view of building performance with emphasis on life cycle impacts. In HK–BEAM, the assessment is not finalized until a building is completed ensuring that 'Green and Sustainable' practices are implemented through the entire project cycle and the project meets the desired goals and performance. The 'New Building' certification system of HK–Beam is also well synchronized with its 'Existing Building' certification, for ex, a new building certified under the HK–BEAM 4/04 and suitably operated and maintained would attain a similar grade under HK–BEAM 5/04 some years later.

HK–BEAM combines the assessment of various key aspects of building performance embracing

- Hygiene, health, comfort amenity
- Land use, site impacts and transport
- Use of materials, recycling and waste management
- Water quality, conservation and recycling
- Energy efficiency, conservation and management

HK–BEAM also exempt building from attempting certain criteria when an issue or past of an assessment is not applicable to particular circumstance or a particular building type. The overall assessment grade is lies on percentage (%) of applicable credits. Given the importance of indoor environment quality, it is compulsory to obtain a minimum percentage (%) of credits for IEQ in order to qualify for the overall grade.

1.2.5 GB-Tool

GB-Tool was developed by the International Framework Committee for the Green Building Challenge, an international project that has involved more than 25 countries since 1998. GB-Tool is designed to be adapted by sponsors to reflect regional context & conditions. It includes various criteria in categories such as Project Planning and Development; Site Selection, Energy and Resource Consumption; Environmental Loadings; Indoor Environmental Quality; Functionality; Long-Term Performance; and Soci-Economic Aspects. Criteria are assessed using the scales that are based on local benchmarks of 'typical' practice; buildings can score –1 if below typical practice or from +1 to +5, representing good to very high performance. The benchmarks of typical practice and weightings of criteria are set by the sponsoring organization to represent local, regional, or national codes, practice, context, conditions, and priorities. GB-Tool major categories of criteria include the following:

- Energy consumption is assessed through the combined use of non-renewable energy (embodied and operational), usage of renewable energy, electrical demand and commissioning.
- Resource consumption is assessed through the materials used (recycled, salvaged, bio-based and sustainably harvested, locally produced, designed for disassembly, re-use, or recycling) and building systems, water use for irrigation, and occupant use.
- Environmental loadings includes solid wastes, storm water, waste water, site impacts, GHG emissions, other atmospheric emissions and other local and regional impacts.
- Indoor environmental quality is assessed by monitoring of indoor air quality, ventilation, temperature & relative humidity, daylight and illumination, and noise and acoustics.
- Other criteria include selection of possible site (in terms of brown fields, land use, access to transportation & amenities), project planning, urban design (density, compatibility, mixed uses, native species, and wildlife corridors), building controls, flexibility and adaptability, maintenance of operating performance, and a few soci-economic measures.

1.3 Introducing GRIHA

Most of the internationally devised rating systems have been tailored to suit the building industry of the country where they have been developed. TERI, a government institute for research; being deeply committed to every facet of sustainable development, took upon self the responsibility of performing as a driving force to popularize green buildings by developing a tool for measuring and rating a building's environmental performance in the context of India's varied climate & building practices. This tool, by its quantitative & qualitative assessment criteria, would be able to 'rate' a building on the degree of its 'greenness'. The rating shall evaluate the environmental performance of a building holistically over its entire life span, thereby providing an authoritive standard for what constitutes a 'green building'. The evaluation system, based on environmental principles & accepted energy, seeks to strike a balance between the emerging concepts & established practices, both international as well as national. The criteria/guidelines appraisal may be revised every three-four years to inculcate the latest scientific developments during this period. On a wider scale, this system, along with the and processes & activities that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, reducing the stress on natural resources & improving energy security.

The rating applies to new building stock – commercial, institutional, and residential – of varied functions. Endorsed by the MNRE, Government of India as of November 31 2008, GRIHA is a five star rating system for green buildings which emphasises on passive solar techniques for optimizing indoor thermal & visual comfort. In order to button hole the energy efficiency, GRIHA encourages optimization of building design to reduce conventional energy demand and further optimize energy performance of the building within specified comfort limits. A building is appraised on its predicted performance over its entire life span from inception through operation.

GRIHA was developed as an indigenous building rating system, particularly to address and assess non-air conditioned or partially air conditioned buildings. GRIHA has been built to rate institutional, commercial & residential buildings in India emphasizing regional climatic conditions national environmental concerns, and indigenous solutions.

GRIHA stresses on usage of passive solar techniques for optimizing thermal & visual comfort indoors, and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort.

GRIHA integrates all concerned Indian codes and standards for buildings and function as a tool to facilitate implementation of the same.

1.4 Development of GRIHA — the national rating system

GRIHA, the national green building rating system, was developed by TERI after a thorough in depth study & understanding of the current internationally accepted green building rating systems & the prevailing building practices in India. The grading system was developed by the Centre for Research on Sustainable Building Science (CRSBS), TERI. CRSBS has been set up in TERI to facilitate development and mainstreaming of sustainable buildings, to meliorate performance levels of surviving buildings, & raise cognizance on sustainable buildings. CRSBS comprising of planners, engineers, architects, & environmental specialists has been offering environmental design solutions for habitat and buildings of various complexities and functions for nearly two decades. With extensive experience in the field of sustainable and green building design and operation, the team came up with the GRIHA framework in 2006. Before to coming up with the indigenous rating system for India, the team has extensively researched on several international rating systems (some of them have been listed above). The team has effectively utilized the several multidisciplinary strengths and experiences of their colleagues at TERI to arrive at the tool that addresses cross-cutting issues in the designing, development, operation of a green building.

The primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness' of buildings. The rating system follows rightest practices along with national/ international codes that are applicable to the green design of buildings.

The green building rating system devised by TERI is a voluntary scheme. It has derived useful inputs from the building codes/guidelines being developed by the BEE (Bureau of Energy Efficiency), the MNRE (Ministry of New and Renewable Energy), MoEF (Ministry of Environment and Forests), and the BIS (Bureau of Indian Standards). The rating system aims to accomplish efficient resource utilization and to enhance resource efficiency and quality of life in buildings.

GRIHA has been adopted as a NRS (national rating system) under the MNRE, Government of India, as of 1 November 2006. The Ministry of New & Renewable Energy has set up a technical advisory committee comprising of eminent professionals.

1.5 How to get a building rated?

All buildings, except for industrial ones, which are in the design stage, are entitiled for certification under the GRIHA system. Buildings include offices, spaces, institutional buildings, hotels, hospital buildings, health care facilities, and housing complexes.

Registration

- A project has to be registered with ADaRSH (GRIHA secretariat) by filling in an online registration form available on the GRIHA website (www.grihaindia.org)
- Registration cost details are available on the Web. Registration should preferably be done at the beginning of a project, as there are various small & large issues that need to be addressed at the pre-design stage.
- The registration process comprises of access to the essential information related to rating, application form, list of submissions, score points, and the weightage system, and one day training for the registered projects.

During the training session, the listed areas as below are covered.

- Overview of the green building design
- Explanation of the grading system and criteria and points related to rating
- Online access to the rating tool
- Documentation process through usage of online forms
- Evaluation process

GRIHA is backed by a complete web based online document submission and evaluation system.

1.6 GRIHA evaluation process

The buildings shall be evaluated and rated in a three-tier process.

The GRIHA team shall first review the mandatory criteria and reject a project in the event of non-compliance with such criteria. The team shall then check the documentation submitted for the optional criteria. The checking is done by the GRIHA team to ensure that all templates and drawings are filled-in and to ensure that the documentation is complete in all respects (for the attempted criteria). All documents shall be checked and vetted through the appraisal process as outlined by GRIHA. The GRIHA team compiles the first evaluation report and sends to the client. The client is then required to resubmit details as requested for by the Secretariat in the first evaluation report.

The documentation shall now be sent to the GRIHA evaluators comprising of renowned sector experts from landscape architecture, lighting and HVAC design, renewable energy, water and waste management, and building materials. The evaluators shall vet the documentation and independently review the documents for the award of points. The evaluator shall award provisional points (if documentation is in order as per his/her evaluation) and also comment on specific criteria, if need be. The evaluation report shall be sent to the project proponent to review the same and, if desired, take steps to increase the score. The report shall elaborate on the results of the evaluation committee along with its comments. The report shall also list the criteria for which the documentation is incomplete/inadequate/inconsistent, detailing all the required information. The client shall then be given one month to resubmit the document with necessary modifications. The resubmitted report should comprise only of additional documents/information desired in the evaluation report, which shall again be put through the vetting process as described above. The evaluation committee shall then award the final score, which shall be presented to an advisory committee comprising of eminent personalities and renowned professionals in the field for approval and award of rating. Provisional rating is awarded that is converted to final confirmed rated on meeting compliance as per Criterion 32. The rating shall be valid for a period of five years from the date of commissioning of the building. GRIHA reserves the right to undertake a random audit of any criteria for which points have been awarded.

1.6.1 Scoring method and award of rating

- The registration form shall request details of top soil, tree cover, hot water requirement, waste water generation, organic solid waste generated.
- The selectively applicable criteria cannot be attempted by projects that do not meet the threshold values for the selectively applicable criteria.

- The project shall be rated on applicable criteria only and shall be given percentage scoring for example; a project scoring 81% out of applicable points shall qualify for a 4 star rating.
- The information will be provided to ADaRSH (GRIHA secretariat) by the applicant and the Secretariat will decide the points which are applicable or inapplicable for the particular project.

1.7 Scoring points under GRIHA

GRIHA is a guiding and performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criterion has points assigned to it. It means that a project intending to qualify have to meet with each criterion and earn points. Compliances, as specified in the relevant criterion, have to be submitted in the prescribed format. While the intent of some of the criteria is self-validating in nature, there are others (for example energy consumption, thermal and visual comfort, noise control criteria, and indoor pollution levels) which need to be validated on-site through performance monitoring. The points related to these criteria (specified under the relevant sections) are awarded provisionally while certifying and are converted to firm points through monitoring, validation, and documents/photographs to support the award of point.

The set of 34 criteria of GRIHA shall be broadly classified into two categories – applicable and selectively applicable. The applicable criteria has two further sub categories – mandatory and optional/non mandatory.

1.7.1 Criterions for GRIHA (34)

S.no	Description	Points	
Criterion 1	Site Selection	1	Partly mandatory
Criterion 2	Preserve and protect landscape during construction/compensatory depository forestation.	5	Partly mandatory, if applicable
Criterion 3	Soil conservation (post construction)	2	
Criterion 4	Design to include existing site features	4	
Criterion 5	Reduce hard paving on site	2	Partly mandatory
Criterion 6	Enhance outdoor lighting system efficiency	3	
Criterion 7	Plan utilities efficiently and optimize on-site circulation efficiency	3	
Criterion 8	Provide, at least, minimum level of sanitation/safety facilities for construction workers	2	Mandatory
Criterion 9	Reduce air pollution during construction	2	Mandatory
Criterion 10	Reduce landscape water requirement	3	
Criterion 11	Reduce building water use	2	
Criterion 12	Efficient water use during construction	1	
Criterion 13	Optimize building design to reduce conventional energy demand	8	Mandatory
Criterion 14	Optimize energy performance of building within specified comfort limits	16	Partly mandatory
Criterion 15	Utilization of fly-ash in building structure	6	
Criterion 16	Reduce volume, weight, and time of construction by adopting efficient technology for example, pre-cast systems, ready-mix concrete, and so on)	4	
Criterion 17	Use low-energy material in interiors	4	
Criterion 18	Renewable energy utilization	5	Partly mandatory
Criterion 19	Renewable energy based hot- water system	3	
Criterion 20	Waste water treatment	2	
Criterion 21	Water recycle and reuse (including rainwater)	5	
Criterion 22	Reduction in waste during construction	1	
Criterion 23	Efficient waste segregation	1	
Criterion 24	Storage and disposal of wastes	1	
Criterion 25	Resource recovery from waste	2	
Criterion 26	Use of low VOC paints/adhesives/sealants	3	
Criterion 27	Minimize ozone depleting substances	1	Mandatory
Criterion 28	Ensure water quality	2	Mandatory
Criterion 29	Acceptable outdoor and indoor noise levels	2	
Criterion 30	Tobacco and smoke control	1	Mandatory
Criterion 31	Universal accessibility	1	
Criterion 32	Energy audit and validation		Mandatory
Criterion 33	Operations and maintenance protocol for electrical and mechanical equipment	2	Mandatory
Criterion 34	Innovation (beyond 100)	4	
		104	

Table 1.1 Criterions for Green Buildings as Per GRIHA, with points enclosed

1.7.2 Selectively applicable criteria

These are the criteria that may not apply to a project due to technical constraints or due to the fact that its application may not add sufficient environmental benefit in the rating scale. The registered project shall not apply for this/these criteria and all the selectively applicable criteria shall be decided at registration stage. The registration form shall be expanded to ensure that requisite details are obtained to enable ADaRSH to decide on applicability of these criteria for the project. These criteria and corresponding non applicability conditions are as follows.

- ✓ Criterion 2 : Preserve and Protect Landscape during Construction
- ✓ Criterion 3: Soil Conservation
- ✓ Criterion 19: Renewable Energy Based Hot Water System
- ✓ Criterion 20: Waste Water Treatment
- ✓ Part of Criterion 21: Water Recycle and Reuse (including Rainwater)
- ✓ Criterion 24: Storage and Disposal of Wastes

1.7.3 Applicable criteria

All other criteria other than mentioned above shall be applicable to all registered projects. The criteria those are not applicable for a project shall be determined by ADaRSH (GRIHA secretariat) during registration. Information of top soil quality, mature trees on site, hot water demand, quantum of waste water generated, groundwater table, quantum of waste generated shall be sought during registration. The respective criteria as mentioned above shall not apply in case if the non applicability condition applies. The project shall be rated on the applicable points only.

1.8 Evaluation system of GRIHA

GRIHA has a 100-point system consisting of some core points, which are mandatory to be met while the rest are non mandatory or optional points, which can be earned by complying with the commitment of the criterion for which the point is allocated.

Different levels of certification (one star to five stars) are awarded based on percentage of points earned. The minimum percentage required for certification is 50. Buildings scoring 50–60 percentage points, 61–70 percentage points, 71–80 percentage points, and 81–90 percentage points will get one star, two stars, three stars, and four stars, respectively. A building scoring 91–100 percentage points will receive the maximum rating, which is five stars.

% Points scored	Rating
50–60	One star
61–70	Two stars
71–80	Three stars
81–90	Four stars
91–100	Five stars

Table 1.2 Rating Stars with respect to points scored

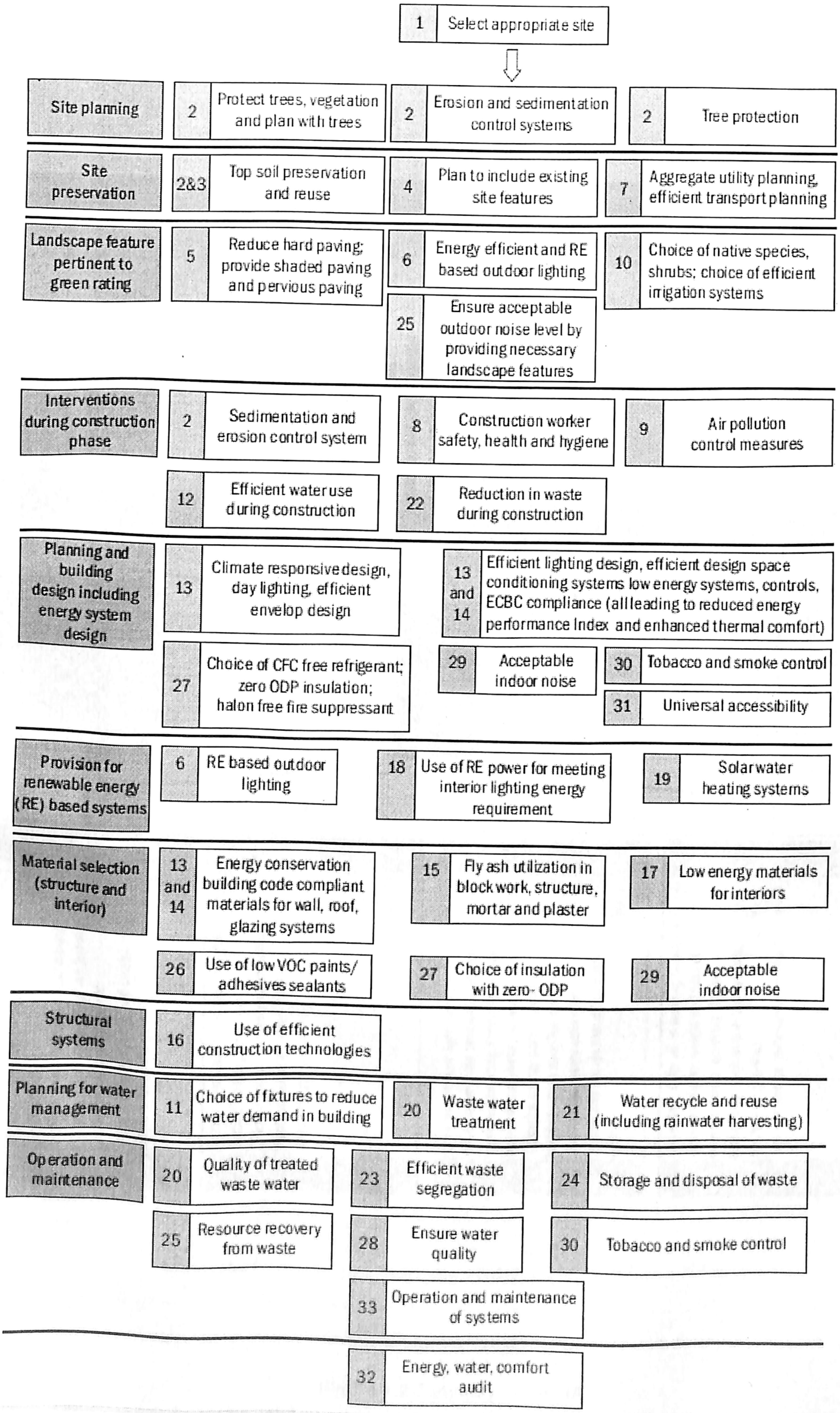


Figure 1.1 Various Criterions for GRIHA Under respective headings

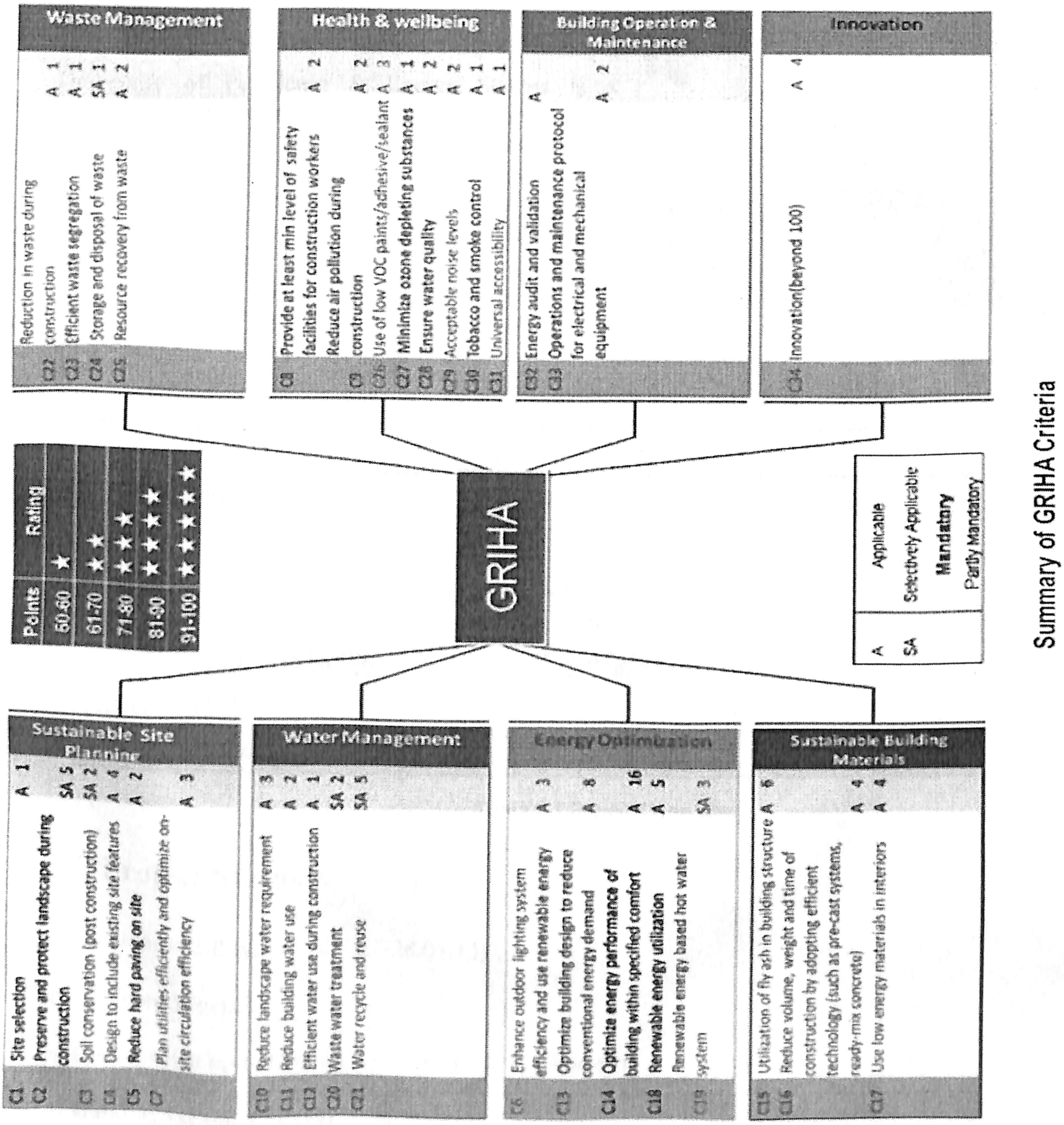
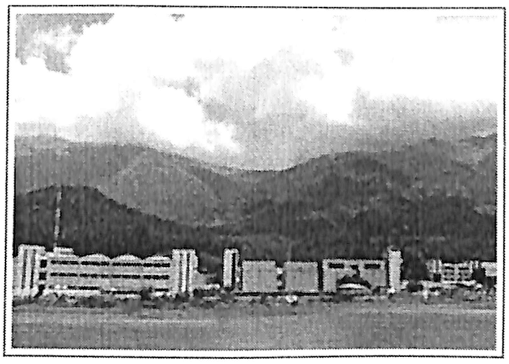


Figure 1.2 Summary of GRIHA

CHAPTER 2 | GRIHA RATING FOR UPES G & H BLOCK

2.1 Location:

University of Petroleum & Energy Studies is a premium institution set amidst the picturesque foothills of the Himalayan Range in Dehradun. The construction work of this 30 Acre project commenced in the year 2003 and is now complete with 28 buildings which house state of the art facilities for its staff and students.



PROJECT HIGHLIGHTS	
GRIHA Rating	5 Star GRIHA Rating (Applying)
Site	H & I classroom block
Location	Dehradun, Uttrakahnad
Site Area	1552.6109 sqm
Energy Performance Index EPI	35.22 kWh/sqm/year
Project Start Date	15-12-12
Project Completion Date (Estimated)	28-07-13

Table 2.1 Project Over-View

2.2 Project Status

Projected: 178 Days (15.12.12 – 28.07.13)

Completed Work:

a) Construction up-to Ground Level (15-12-12 to 25-04-13)

1. Building Layout. (7 days)
2. Excavation for foundation & PCC under foundation (20 days).
3. Waterproofing under raft. (22 days)
4. Casting of foundation & steach slab. (18 days)
5. Casting of column & retaining wall (27 days)
6. Waterproofing for retaining wall (20 days)
7. Shuttering & steel binding for basement roof slab (24 days)
8. Casting of basement roof slab (24 days)

9. Brick work in basement (28 days)
10. Plastering in basement (30 days)
11. Flooring in basement (32 days)

b. Construction up to Ground Floor

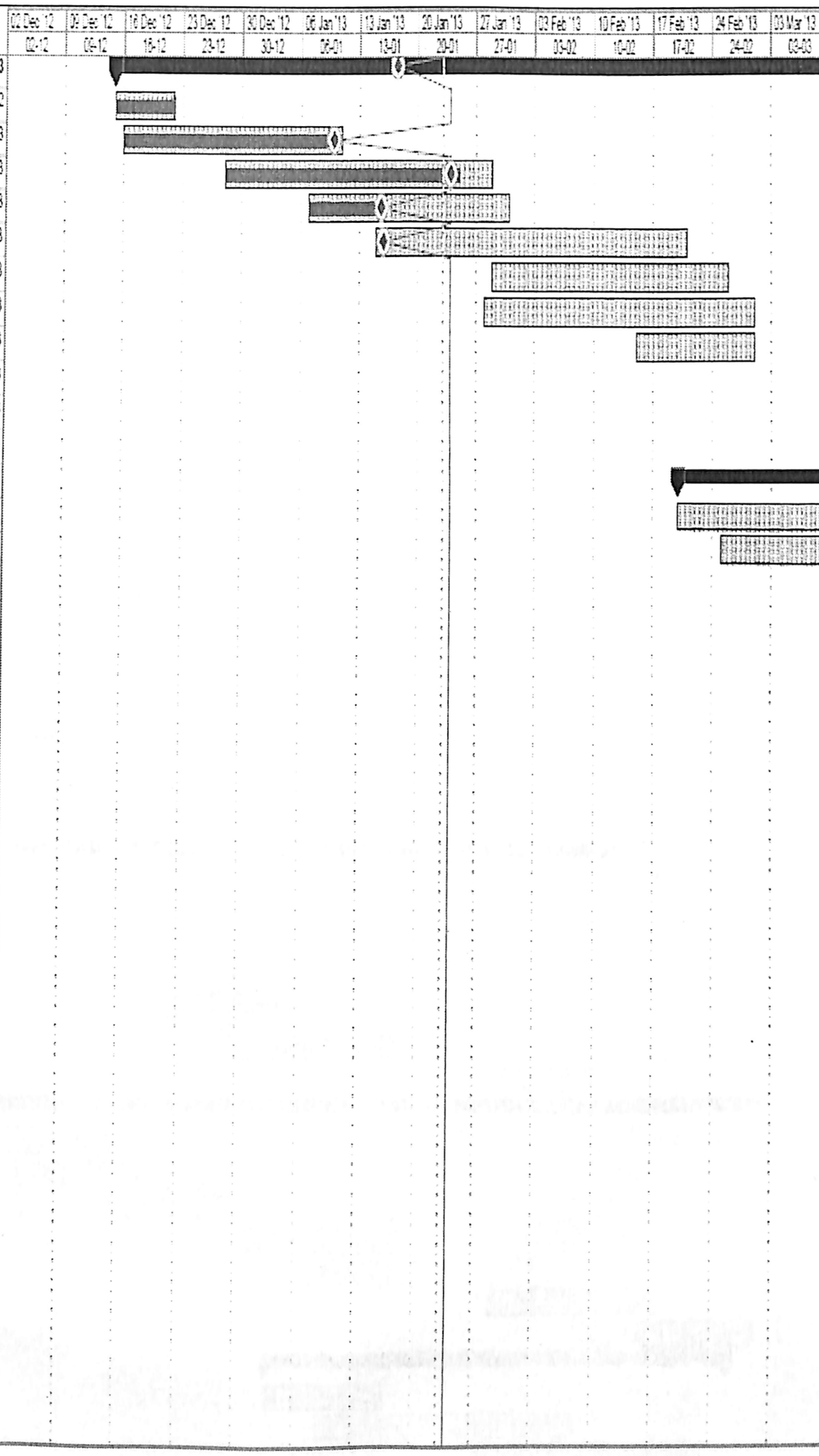
12. Casting of column (27 days)
13. Shuttering & reinforcement for slab (24 days)
14. Casting for Slab (24 days)

c. Construction upto 1st Floor

15. Casting of column (27 days)
16. Shuttering & reinforcement for slab (24 days)
17. Casting for slab (24 days)

VILLAGE: BIDHOLI DEHRADUN

ID	0	Task Name	Start	Finish
1		**Construction upto GL**	Sat 15-12-12	Thu 25-04-13
2		Building Layout	Sat 15-12-12	Fri 21-12-12
3		Excavation for foundation & PCC under foundation	Sun 16-12-12	Thu 10-01-13
4		Waterproofing under raft	Fri 28-12-12	Mon 28-01-13
5		Casting of foundation & steach slab	Mon 07-01-13	Wed 30-01-13
6		Casting of column & retaining wall	Tue 15-01-13	Wed 20-02-13
7		Waterproofing for retaining wall	Tue 29-01-13	Mon 25-02-13
8		Shuttering & steel binding for basement roof slab	Mon 28-01-13	Thu 28-02-13
9		Casting of basement roof slab	Fri 15-02-13	Thu 28-02-13
10		Brick work in basement	Mon 18-03-13	Mon 15-04-13
11		Plastering in basement	Thu 21-03-13	Fri 19-04-13
12		Flooring in basement	Mon 25-03-13	Thu 25-04-13
13		**Construction upto G/Floor**	Wed 20-02-13	Thu 30-05-13
14		Casting of column	Wed 20-02-13	Fri 15-03-13
15		Shuttering & reinforcement for slab	Mon 25-02-13	Tue 26-03-13
16		Casting for slab	Fri 15-03-13	Thu 28-03-13
17		Brick work for walls	Thu 18-04-13	Tue 14-05-13
18		Wall Plastering	Sat 27-04-13	Mon 20-05-13
19		Flooring	Sat 27-04-13	Fri 24-05-13
20		Door shutters & wall painting	Tue 14-05-13	Thu 30-05-13
21		**Construction upto F/Floor**	Wed 20-03-13	Mon 15-07-13
22		Casting of column	Wed 20-03-13	Mon 15-04-13
23		Shuttering & reinforcement for slab	Wed 27-03-13	Fri 26-04-13
24		Casting for slab	Mon 15-04-13	Tue 30-04-13
25		Brick work for walls	Mon 20-05-13	Wed 05-06-13
26		Wall Plastering	Fri 24-05-13	Fri 07-06-13
27		Flooring	Tue 28-05-13	Tue 25-06-13
28		Door shutters & wall painting	Mon 01-07-13	Mon 15-07-13
29		**Construction upto S/Floor**	Wed 01-05-13	Wed 31-07-13
30		Casting of column	Wed 01-05-13	Mon 20-05-13
31		Shuttering & reinforcement for slab	Tue 07-05-13	Tue 28-05-13
32		Casting for slab	Sat 18-05-13	Fri 31-05-13
33		Brick work for walls	Mon 03-06-13	Thu 20-06-13
34		Wall Plastering	Mon 10-06-13	Tue 25-06-13
35		Flooring	Mon 01-07-13	Sat 20-07-13
36		Door shutters & wall painting	Thu 11-07-13	Wed 31-07-13
37		**External work**	Wed 05-06-13	Sun 28-07-13
38		Staircase mutty	Wed 05-06-13	Tue 18-06-13
39		Waterproofing of tarroe	Tue 11-06-13	Wed 10-07-13
40		Grite wash	Tue 25-06-13	Thu 25-07-13
41		Kota stone cladding on staircase	Wed 26-06-13	Sun 28-07-13



...JECT: CLASS ROOM BLOCK H & I	Task	Progress	Summary	External Tasks	Deadline
...E: 15/12/2012	Split	Milestone	Project Summary	External Milestone	

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Figure 2.1 Gantt Chart showing the project status-1

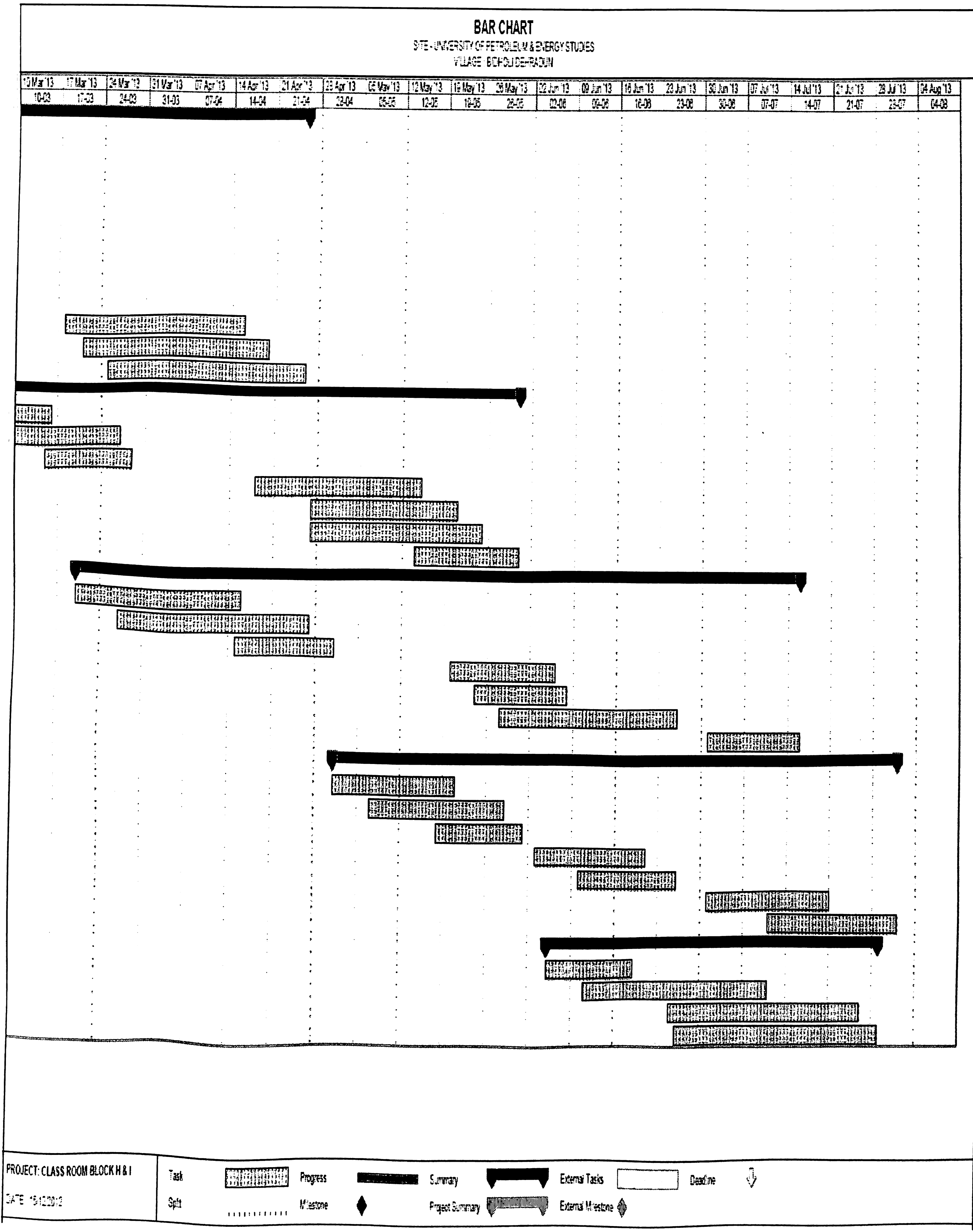

Figure 2.2 Gantt Chart showing the project status-2

CHAPTER 3 | IMPLEMENTED CRITERIONS

3.1 Criterion 1 Site selection

3.1.1 Objective

Site selection is the first step to a sustainable habitat and needs to be done appropriately, prior to commencement of design phase. Site selection and analysis should be carried out to create living spaces that are in harmony with the local environment. The development of a project should not cause damage to the natural surroundings of the site but, in fact, should try to improve it by restoring its balance. Thus, site selection should be carried out in light of a holistic perspective of

- Preservation and optimal use of the environment
- Land use
- Development intensity
- Social well-being

(*in accordance with NBC 2005 Part 3 development control rules and general building requirements*)

3.1.2 Justification:

The site has been located under the non – hazardous zone. Hence the criterion has been fulfilled partially and there is no objection for developing a site here. And also there is no water body nearby within 30 meters. Hence the criterion has fulfilled at great case.

There is a bus stand nearby at a distance of half a kilometre hence the criterion has been fulfilled fully. These reduces the pressure on the under developed land.

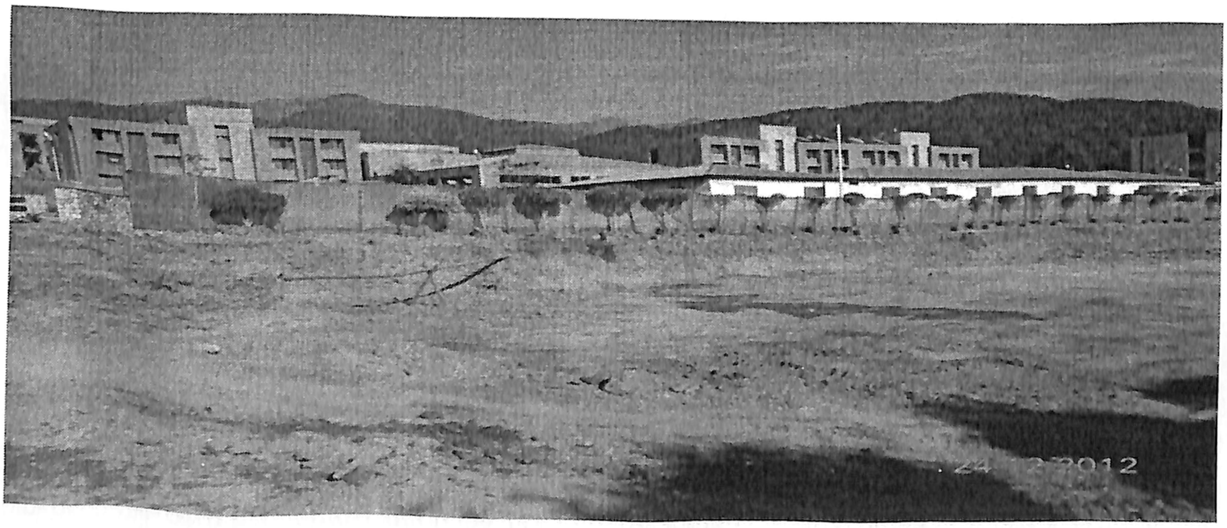

Figure 3.1 Site Photograph for Criterion 1

Figure 3.2 Site Photograph for Criterion 1

3.2 Criterion 2 Preserve and protect landscape during construction

3.2.1 Objective

To preserve the existing landscape and protect it from degradation during the process of construction. (*in accordance with NBC 2005 Part 10*)

3.2.2 Justification:

Since the campus has been located in the valley the spilling has been provided naturally and also the roads has been constructed accordingly there is no water has been stayed off in the site premises. This fulfilled the criterion at maximum points. And more plants have been planted and it has been maintained properly. Hence the criterion has been fulfilled. Top soil has been has been maintained and it has been put on some vegetative areas.

3.3 Criterion 3 Soil conservation (till post-construction)

3.3.1 Objective

Conserve top soil till after completion of construction activity. (*in accordance with NBC 2005 Part 10*)

- Ensure adequate fertility of the soil to support vegetative growth.
- Ensure adequate topsoil laying for vegetative growth.
- Ensure stabilization of soil in the area where the topsoil is vulnerable to erosion.

3.3.2 Justification:

In order to minimize impact of site development on the environment and surroundings, several best practice guidelines were adopted like demarcation of site for construction, installation dust screen around the disturbed area to prevent air pollution and spillage to undisturbed site area. Top soil was excavated, stored and preserved outside the disturbed construction site. Erosion control systems were adopted and several trees on site were protected.

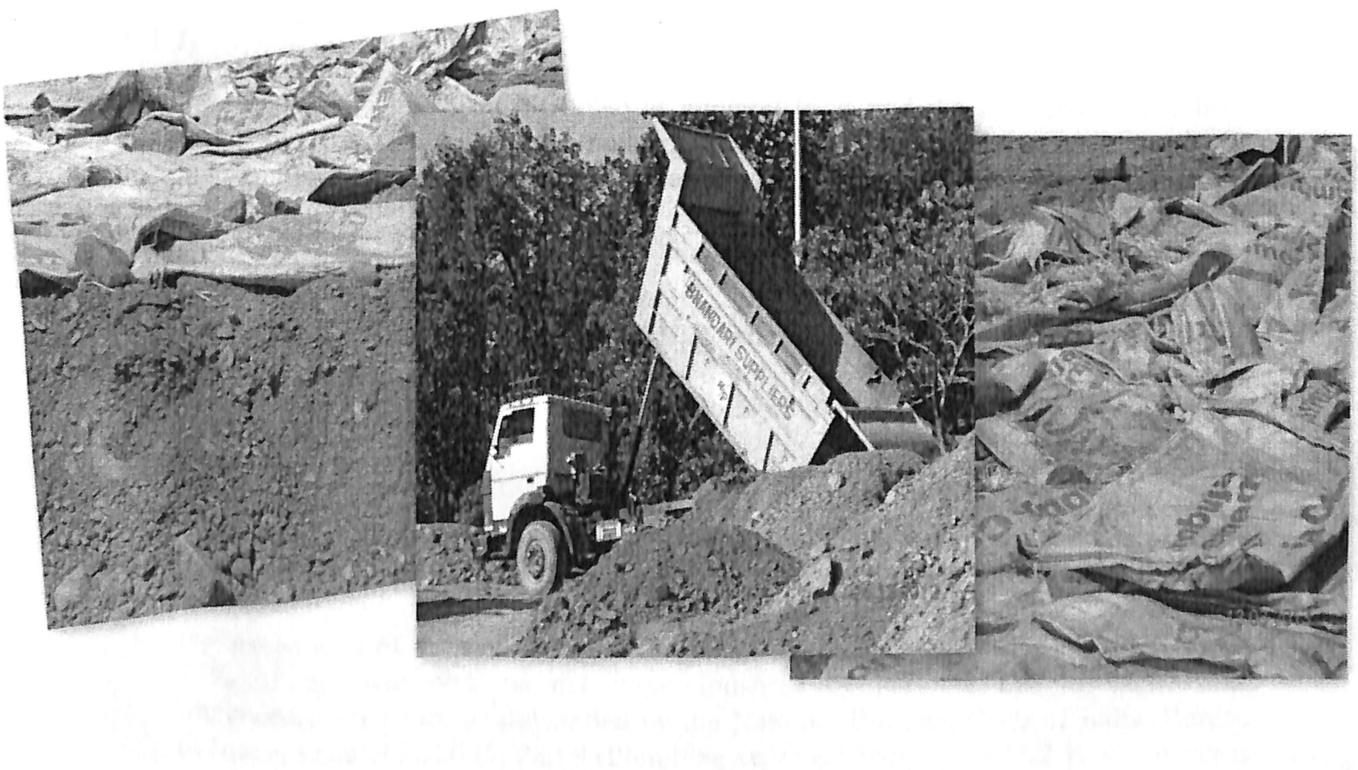

Figure 3.3 Site Photograph for Criterion 3

3.4 Criterion 4 Design to include existing site features

3.4.1 Objective

The natural functions of a plot of land (hydrologic, geologic, and microclimatic) can be disrupted by the placement of a building on it. The design of a green building will factor in ways in which the natural site features can be protected or even restored.

Layout the site activities and building requirements after carrying out detailed site analysis so as to ensure sustainable site development in tune with its topographical, climatic, and ecological character.

- Carry out a comprehensive site analysis to identify site characteristics that can be used to harness natural resources (like solar energy, wind, and water) and the potential qualities of the landforms that could contribute to making different areas of the site visually and thermally more comfortable for users.
- Locate various activities of the scheme after careful site analysis and assessment so as to protect ecologically sensitive areas and reduce damage to the natural ecosystem.
- Identify areas of the site that were damaged during construction.

3.4.2 Justification

The natural ecosystem has been disrupted at minimal basis and the site features has been included accordingly with having the building designs has been made to have maximum exposure of sunlight and having maximum wind co-efficient to reduce the demand needed by the building.

3.5 Criterion 5 Reduce hard paving on-site and/or provide shaded hard-paved surfaces

3.5.1 Objective

To reduce hard paving on-site (open areas surrounding building premises) and/or provides shade on hard-paved surfaces to minimize the heat island effect and imperviousness of the site.

- Net paved area of the site under parking, roads, paths, or any other use not to exceed 25% of the site area or net imperviousness of the site not to exceed the imperviousness factor as prescribed by the National Building Code of India, Bureau of Indian Standards, 2005; Part 9 (Plumbing services) Section 5.5.11.2.1, whichever is more stringent.
- Total surface parking not to exceed the area as permissible under the local bylaw and more than 50% of the total paved area to have pervious paving/open grid pavement/grass pavers, or
- A minimum 50% of the total paved area (including parking) to have shading by vegetated roof/pergola with planters, or

- A minimum 50% of the total paved area (including parking) to be topped with finish having solar reflectance of 0.5 or higher.

3.5.2 Justification:

The criterion is being fulfilled by having the hollow paving in the block which will in turn reduce the heat island effect along the building.

3.6 Criterion 8 Provide minimum level of sanitation/safety facilities for construction workers

3.6.1 Objective

To ensure the health and safety of workers during construction, with effective provisions for the basic facilities such as sanitation and drinking water, and safety of equipment or machinery.

- Comply with the safety procedures, norms and guidelines (as applicable) as outlined in NBC 2005 (BIS 2005c).
- Adopt additional best practices and prescribed norms as in NBC 2005 (BIS 2005c).
- Provide clean drinking water to all workers.
- Provide adequate number of decentralized latrines and urinals to construction workers.

3.6.2 Justification

Toilets and the other basic amenities is being provided during construction of the building in the campus. The construction workers enjoys the extreme comfort during the periods of construction, which include health care facilities, shelter, clean drinking water, toilets, electricity for basic usage.

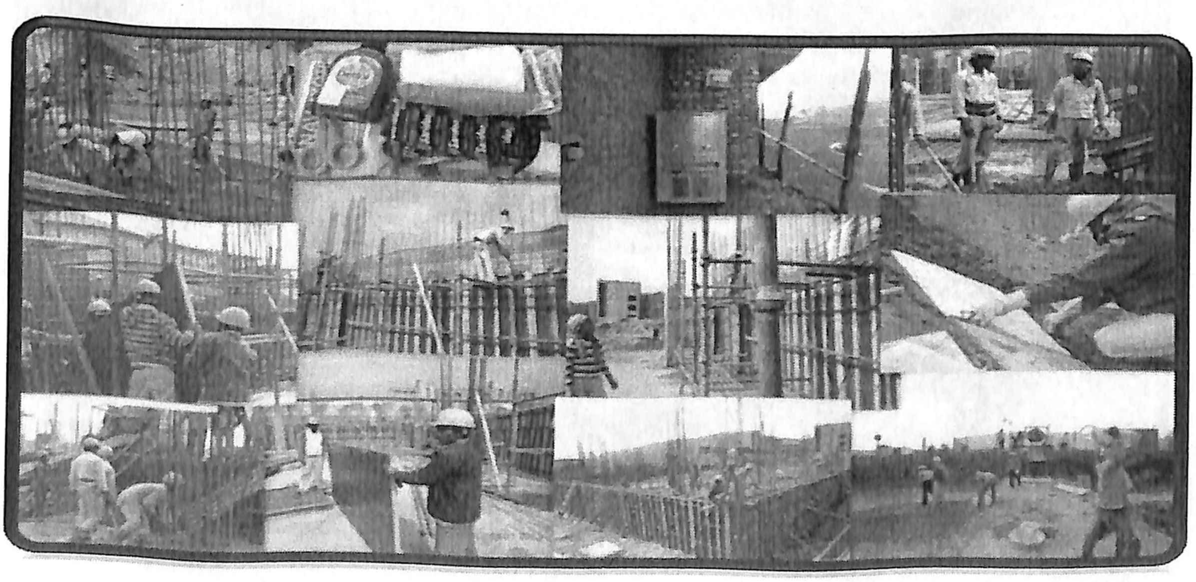

Figure 3.4 Site Photograph for Criterion 8

3.7 Criterion 9 Reduce air pollution during construction

3.7.1 Objective

The dust generated by various construction site activities can contribute significantly to air pollution. Dust and outdoor air pollutants can cause respiratory problems. Good construction practices involve major mitigation measures for prevention or minimization of air pollution from construction activities. This criterion aims to reduce air pollution due to on–site construction.

- Adopt measures to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices should be followed (as adopted from international best practice documents and codes).
- Provision in the contract document that the contractor will undertake the responsibility to prevent air pollution (dust and smoke); ensure that there will be adequate water supply/ storage for dust suppression; devise and arrange methods of working and carrying out the work in such a manner so as to minimize the impact of dust on the surrounding environment; and provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the methods of working, plant equipment, and air-pollution-control system to be used on-site should be made available for the inspection and approval of the engineer-in-charge to ensure that these are suitable for the project.

3.7.2 Justification

Barricading of the site to prevent air pollution up to 3 m.

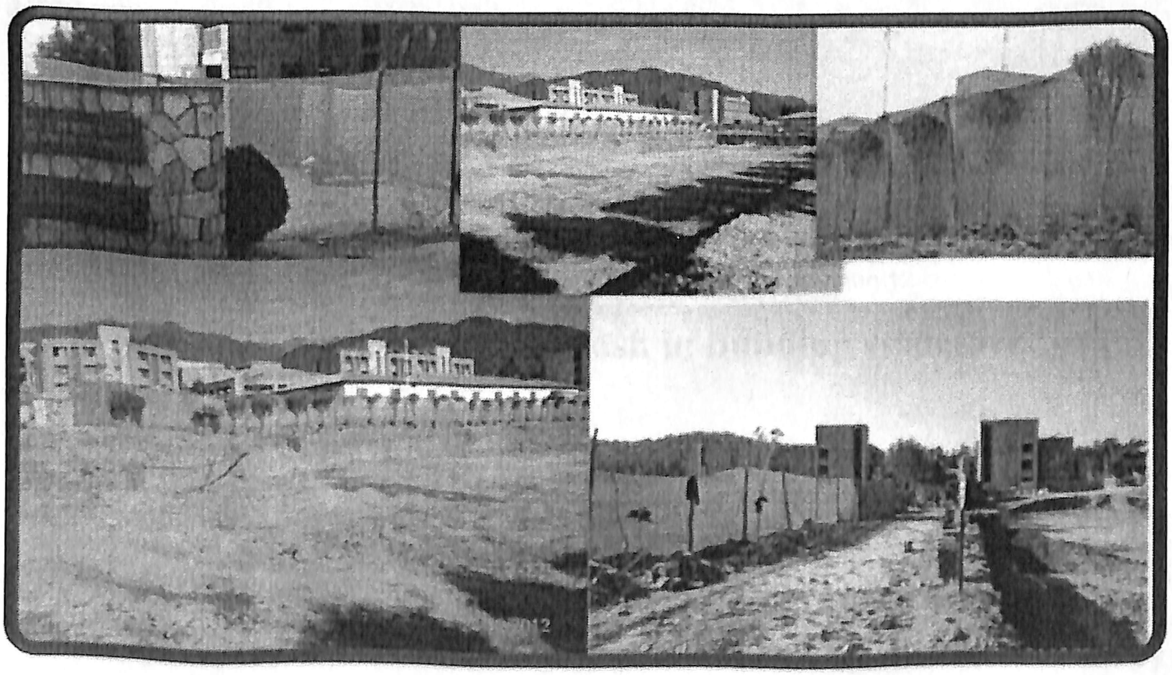

Figure 3.5 Site Photograph for Criterion 9

3.8 Criterion 12 Efficient water use during construction

3.8.1 Objective

To minimize use of potable water during construction activity.

- Use materials such as pre-mixed concrete for preventing water loss during mixing.
- Use recycled treated water.
- Control the wasting of curing water.

3.8.2 Justification

Waste water treated and re-used for landscape water requirement.

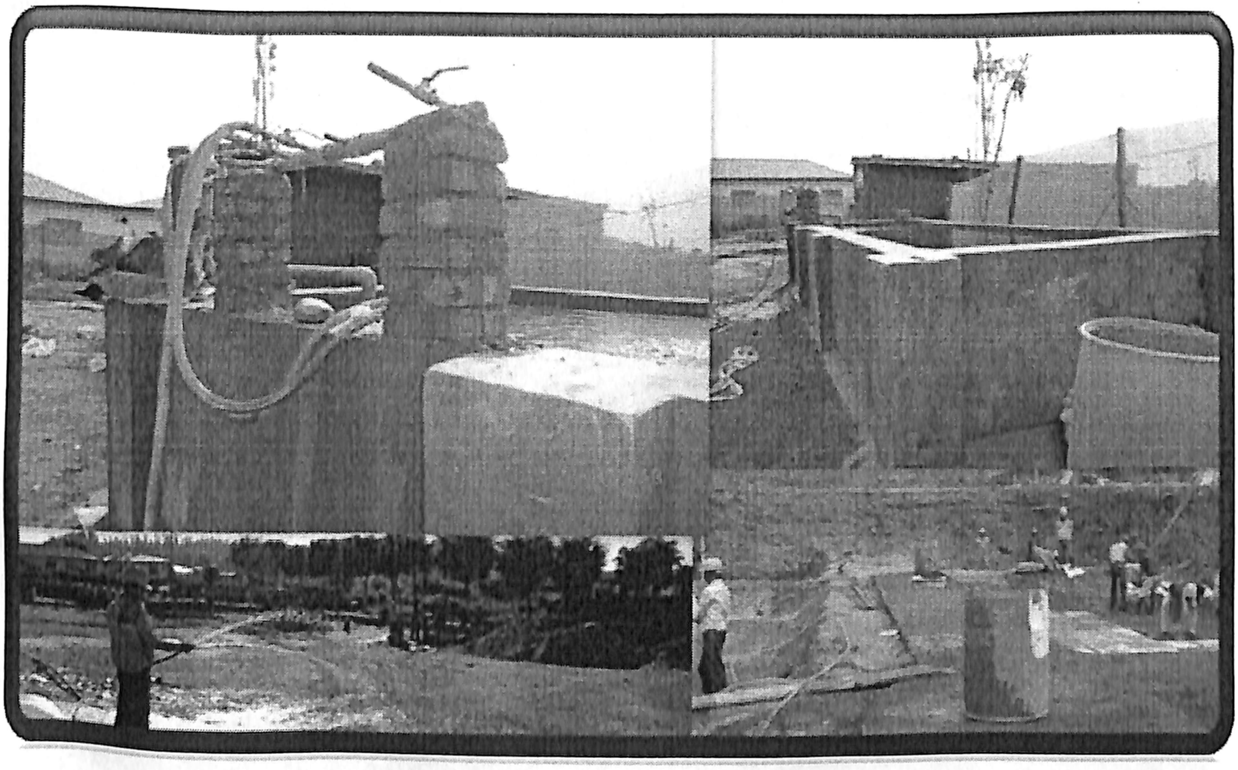

Figure 3.6 Site Photograph for Criterion 12

3.9 Criterion 15 Utilization of fly-ash in building structure

3.9.1 Objective

To use low embodied energy industrial waste fly ash as the construction material. Fly ash, an industrial waste having the properties of cement and very low embodied energy is used in combination with cements that are high in embodied energy.

- RC (reinforced concrete) (including ready-mix concrete) to make use of fly ash by using PPC (Portland pozzolona cement) containing fly ash. A minimum of 15%

replacement of cement with fly ash in PPC (by weight of the cement used) in the overall RC for meeting the equivalent strength requirements.

- Use fly ash in building blocks for the walls.
- Use fly ash in Plaster/masonry mortar by employing PPC. Use plaster and/or masonry mortar, which utilizes a minimum 30% of fly ash in PPC, in 100% wall/ceiling finishes and wall construction, meeting the required structural properties.

3.9.2 Justification

Fly ash has been utilized in the system at an maximum fraction as prescribed and the BOM has been produced with the specification from manufacturers. This give an fulfillment of this criterion.

JAIPRAKASH ASSOCIATES LIMITED
JAYPEE ROORKEE CEMENT GRINDING UNIT
ROORKEE (UK)

JAYPEE

TEST CERTIFICATE
FOR
PORTLAND POZZOLANA CEMENT

Date : 02/02/2013

PARTICULARS	TEST RESULTS OBTAINED	REQUIREMENT OF IS 1489-1991 [PART I]
CHEMICAL TESTING		
Insoluble Residue (%)	31.40	X + 4(100 - X) / 100 MAX #
Magnesia (%)	1.60	6.00 MAX
Sulphuric Anhydride (%)	1.62	3.00 MAX
Total Loss On Ignition (%)	2.70	5.00 MAX
Total Chloride (% by mass)	0.010	0.10 Max (For N.C)* 0.05 Max (For P.C)*
PHYSICAL TESTING		
Fineness (m2 / kg)	356	300 MIN
Setting Time (minutes)		
a) Initial	195	30 MIN
b) Final	275	600 MAX
Soundness		
a) Le-Chat Expansion(mm)	1.00	10.00 MAX
b) Auto clave (%)	0.06	0.8 MAX
Compressive Strength (Mpa)		
a) 3 Days	24.1	16 MIN
b) 7 Days	35.2	22 MIN
c) 28 days	Due	33 MIN

Where X is the declared % of Pozzolana
The above cement complies with IS 1489-1991 [Part I] for PPC Cement

*N.C (NORMAL CONCRETE CEMENT)
*P.C (PRESTRESSED CONCRETE CEMENT)

DESPATCHED ON : 24/01/13
Week No 04/2013

[illegible]

JAYPEE ROORKEE PLANT

Authorised signatory

Figure 3.7 Cement Certificate stating fly-ash content for Criterion 15

3.10 Criterion 16 Reduce volume and weight, and time of construction by adopting efficient technologies (for example, pre-cast systems, and so on.)

3.10.1 Objective

Replace a part of energy-intensive materials with less energy-intensive materials and/or utilize regionally available materials, which use low-energy/energy-efficient technologies.

Structural application

Use of low-energy technologies/materials (not based on the utilization of fly ash), such as roofing/ flooring, columns, and load-bearing walls, for structural applications.Use such technologies to demonstrate a minimum 5% reduction in the overall embodied energy, when compared to equivalent products for the same application, for a 100% structural system used in a building, thus meeting the equivalent strength requirements.

Examples of low-energy products and technologies used in structural applications
Technologies such as pre-stressed slab, extruded structural clay joist and filler slab, hollow floor/ roof slabs, burned clay filler pots with RCC structure, micro-concrete roofing, precast hollow plank roofing, funicular shells, zipbloc system, composite columns, reinforced grouted brick masonry, stone masonry, precast stone blocks, pre-cast concrete blocks, pre-cast finished concrete blocks, light-weight concrete blocks over dense concrete blocks, and rat trap masonry.

Non-structural application: masonry/infill wall system

Use of low-energy technologies/materials (not based on the utilization of fly ash) for non-structural applications. Use such technologies to demonstrate a minimum 5% reduction in the embodied energy, when compared to equivalent products for the same application, for 100% infill wall system used in a building, meeting the equivalent strength requirements.

Examples of low-energy product and technologies in non-structural applications
Infill wall system using traditional mud walling system, stabilized adobe walling, compressed earth blocks, hollow, perforated/ modular bricks, interlocking bricks, traditional stone masonry, pre-cast non-load-bearing concrete blocks, finished concrete blocks, light weight concrete blocks over dense concrete blocks, pre-cast brick panels, composite ferro cement walling, interlocking concrete blocks, rat trap masonry, and so on.

3.10.2 Justification

- Use of Portland Pozzolona cement in structural concrete to reduce embodied energy of the building.
- Use of low energy kota stone in flooring.
- Use of Efficient machinery & technologies for reducing time of construction

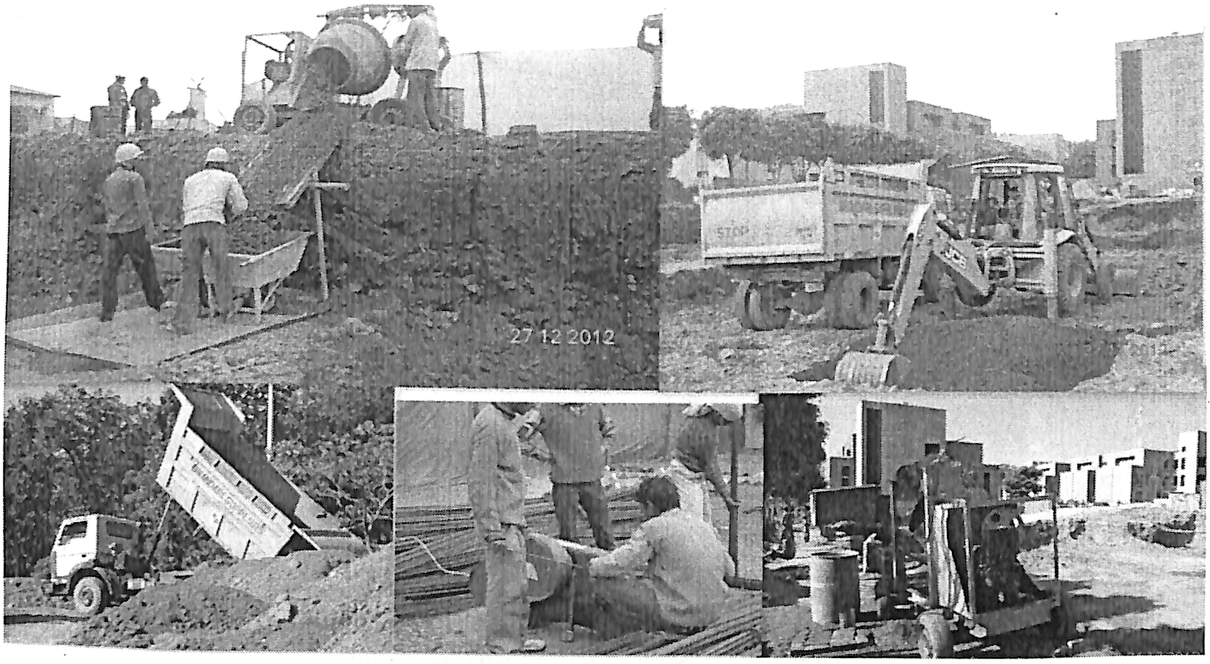

Figure 3.8 Site Photograph for Criterion 16

3.11 Criterion 22 Reduction in waste during construction

3.11.1 Objective

To ensure maximum resource recovery and safe disposal of wastes generated during construction, and to reduce the burden on the landfill.

- Employ measures to segregate the waste on-site into inert, chemical or hazardous wastes.
- Reuse/Recycle the segregated waste and unused chemical/ hazardous wastes such as oil, paint and batteries.
- Inert waste to be disposed off by municipal corporation/local bodies at landfill sites.

3.11.2 Justification

Reuse of waste material where-ever possible.

Figure 3.9 Site Photograph for Criterion 22

3.12 Criterion 23 Efficient waste segregation

3.12.1 Objective

To promote the segregation of waste for efficient resource recovery.

3.12.2 Justification

The construction site has dustbins for waste collection & Segregation.

Figure 3.10 Site Photograph for Criterion 23

3.13 Criterion 24 Storage and disposal of wastes

3.13.1 Objective

To prevent the mixing up of segregated waste before processing or disposal

Allocate a separate space for the collected wasted before transferring it to the recycling/ disposal stations.

3.13.2 Justification

Separate space provided for storage of waste and than its safe disposal.

Figure 3.11 Site Photograph for Criterion 24

3.14 Criterion 30 Tobacco smoke control

3.14.1 Objective

To put in place health strategies such as prohibiting smoking in the indoor areas/building or providing designated/isolated smoking zones within the building designed with separate ventilation systems with higher ventilation rates than the non-smoking areas. This will ensure zero exposure of the nonsmoking occupants to passive smoking.

- In both an air-conditioned/non-air-conditioned buildings, ensure zero exposure of nonsmokers to the tobacco smoke; prohibit smoking on the building premises supported with the company policy.
- Ensure that both air-conditioned/non-air-conditioned buildings provide a designated smoking zone with a controlled environment that ensures restriction of the smoke to the designated area, preferably in the peripheral spaces of the buildings or within the buildings (for multiple-occupancy buildings such as hotels, non-smoking and smoking rooms to be clearly identified).

3.14.2 Justification

The campus has been declared as an "NO SMOKING ZONE".

Figure 3.12 Site Photograph for Criterion 30

3.15 Criterion 34 Innovation points

The enlisted criteria in the rating system are the most critical components contributing to the evolution of a green building. Green building design and operation extend beyond the boundaries defined by the rating system and may cover strategies and options that lead to environmental benefits. The purpose of this category of points is to recognize the measures adopted, which contribute to the overall objective of designing and maintaining of green buildings, and those that are otherwise not covered in the rating system. The following is an indicative list of innovation points. The applicant may submit any other criterion, which they consider as deserving for the award of points, under the rating system. The applied criterion will be evaluated on the merits and demerits of its sustainability benefits. Each Innovation Criterion will carry one point, subject to a maximum of four points.

3.15.1 Objective

Objective

To promote awareness of significant environmental issues by imparting environmental education to the owner or the occupants of the building and to the community as a whole.& develop/suggest various innovative points apart from building construction & implementation such as in the field of social welfare.

3.15.2 Justification

Education of children of labourers through primary school along with MID- DAY meal

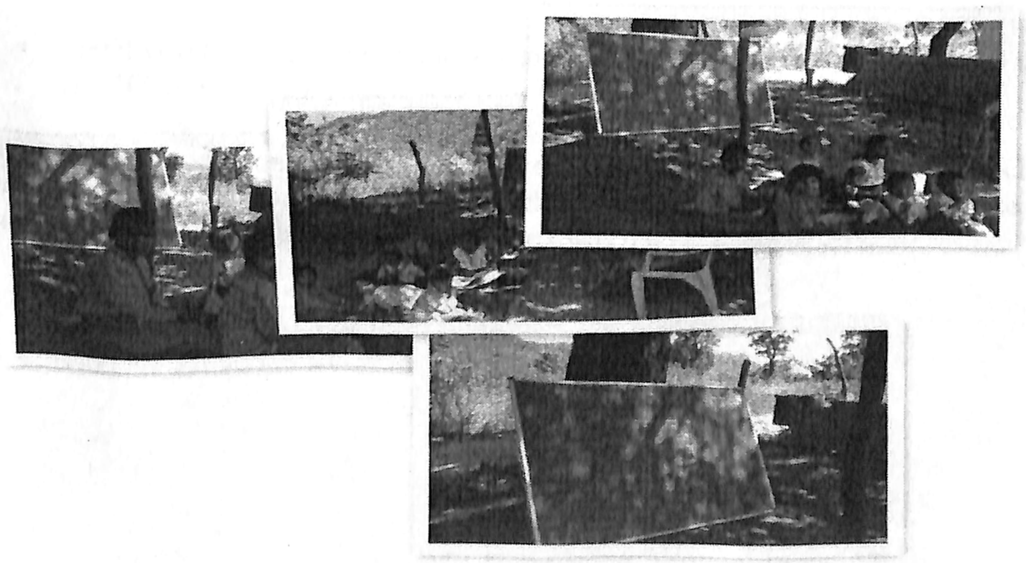

Figure 3.13 Site Photograph for Criterion 34

CHAPTER 4 | CONCLUSIONS & SUGGESTIONS

Various aspects of a green building has been underlined and studied with references to policies and criterions laid down by GRIHA along with TERI. During the study and the live implementation of the project various suggestions were incorporated so as to get the maximum points out of the total available points.

Various suggestions incorporated include:

- Increasing of the site fence to 3m from the existing 2.5 m to prevent dust flow from the construction site to the surrounding
- Creation of the sedimentation tank, thus reducing soil spillage.
- Regular checks and visits of the laborers hatchment to ensure safety of the laborers and their family.
- Monthly medical check-up of the workers by campus resident doctor.
- Compulsory helmets and boots for all workers, site supervisors and engineers.
- Waste segregation by use of different colored bins
- Training programs for site supervisors, Project Engineers & time keepers about green buildings.
- Small vegetative growth on the top soil kept apart as per the criterion no. 3 under GRIHA norms.

With these incorporations the aim for a five star rated GRIHA building seems closer. Certain Criterion needs still to be followed closely during its implementation phase such as renewable energy usage, hard paving of the roads, etc.

Annexure I

Format for submission of proposals for organizing seminars/ symposium/ workshops/ training programmers' etc.

1. Name of Institution organizing the event:
2. Type of event to be organized:
3. Date(s)/ venue of the event:
4. Category of participants:
5. Tentative programme with topics to be covered (copy to be enclosed):
6. Budget break up (item-wise):
7. Expected outcome:

Signature with name & seal of Head of Implementing organization

Format for submission of proposals for organizing publicity and awareness campaign/ publication of documents

1. Name of Institution organizing the activity:
2. Type of activity to be organized:
3. Details of activities to be organized:
4. Budget break up (item-wise; supporting documents for arriving at the figures to be provided):

5 Expected outcome :

Signature with name & and seal of Head of Implementing organization

Annexure II

Statement of Expenditure

1. Name of implementing organization:
2. Type of activity/ event sanctioned:
3. MNES sanction No. & Date:
4. Amount released by MNES:
5. Item-wise Statement of Expenditure:

(In Rupees)

Sr. No.	Item	Amount sanctioned	Expenditure incurred
1.			
2.			
3.			
	Total		

6. Balance to be released/returned:
7. Report on the activity/event:
   (to be enclosed)

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