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An exploratory study on the use of sustainable building materials and emphasis on "Green Projects" in the real estate sector in India: A case study of Jewar Airport, Noida, UP, India.

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Abstract: An analysis on the importance of sustainability and the encouragement of green projects was attempted in this paper. Specific instances on building materials, the project timeline, calculation of energy saved and the use of innovative designs to reduce energy consumption from fossil fuels were examined. The case study of the Jewar airport in Noida, UP was taken as the prime example of the manner in which many companies worked together to try and achieve sustainable practices and a high level of "green" project consumption and innovation. All stakeholders, including the designers, the construction companies and the government, ensured that at every stage of development green practices were followed in the regulatory manner and were at no point violated. This paper looks at all these measures along with actual data to understand the manner in which this was and is being achieved so that it can be a benchmark for future infrastructure projects that are required for a developing economy like India.

Keywords: Green Projects, Sustainability, Jewar Airport, LC3 cement, Fly Ash cement, Capacity building

1. Introduction

India is building at a very large scale that has been largely unmatched. Rapid urbanisation with a growing middle class and large public infrastructure programmes mean that much of the floor area that will be used in 2050 has not been built yet. Analysis by RMI and the National Institute of Urban Affairs estimates that India will double its floor area by 2050 and the associated carbon emissions will likely quadruple (Mendonca, 2025).

Buildings in India already have a large impact on the environment. According to the UN Global Alliance for Buildings and Construction, India's building sector accounts for about 38% of annual primary energy use, 31% of electricity consumption and 32% of national greenhouse gas emissions (GlobalABC, 2025). Apart from the building aspect, a huge amount of the national energy use comes from manufacturing materials like cement, steel and fired bricks.

The choice of building materials and design matters as "A green project is one that is planned, built and operated to reduce its use of energy, water and materials, limit waste and pollution and protect surrounding ecosystems". In India, these projects are assessed against voluntary rating systems like IGBC, GRIHA and LEED and against mandatory codes issued by the Bureau of Energy Efficiency.

These regulations are important because buildings lock in their environmental impact for decades. Buildings constructed today will use energy and water for the next 50 years or more. This means that decisions taken at the design stage have a long-term impact and are hard to change later. Making changes to an existing building to make it energy efficient is usually much more expensive

than designing it correctly from the start. Additionally, building materials carry a large carbon cost before a building is even occupied. The production of cement accounts for roughly 8% of global carbon dioxide emissions, with India being the world's second-largest cement producer (Lehne & Preston, 2018; Indian Chamber of Commerce, n.d.). There are alternatives to cement such as fly-ash bricks, recycled steel, low-carbon concrete and locally sourced materials that can substantially reduce this "embodied" carbon. India has rising temperatures and frequent heatwaves, which increase the consumption of electricity that relies heavily on coal (IEA, 2023). This makes efficient design especially important in India. Design features like shading, insulation, natural ventilation and better quality glass can keep a building cool and comfortable while reducing electricity use. Green buildings also have economic and social advantages. People living or working in them pay lower electricity and water bills, and the air in these buildings is cleaner, which improves working conditions.

As India's infrastructure is growing rapidly, sustainable construction is an important sector and is central to meeting India's commitment to reach net-zero emissions by 2070.

This paper looks at how much sustainable building materials and green project ideas are being used in India's real estate and infrastructure sector. It also looks at whether these projects are financially viable and what the government is doing to encourage them. To answer these questions, the paper uses the case study of Noida International Airport at Jewar, Gautam Buddh Nagar, Uttar Pradesh. The airport started commercial flights on 15 June 2026 and has been described as India's first net-zero emissions airport (Noida International Airport, 2026). Studying it helps to show whether the green goals set for a project are actually followed during construction.

2. Background and Literature Review

2.1 Sustainability and the built environment

According to the World Commission on Environment and Development, sustainable development is development that meets present needs "without compromising the ability of future generations to meet their own needs" (WCED, 1987). In later articles, this idea was broadened and divided into three pillars: environmental protection, economic viability and social equity. These pillars are often called the "triple bottom line" (Elkington, 1997). These pillars are important because a building that saves energy but displaces communities without fair compensation, or a project that is green but too expensive for anyone to build, falls short.

These ideas were formalised in the United Nations Sustainable Development Goals that were adopted in 2015. Several goals that bear directly on real estate are SDG 7: affordable and clean energy, SDG 11: sustainable cities and communities, SDG 12: responsible consumption and production and SDG 13: climate action (United Nations, 2015).

Globally, buildings and construction add up to 37% of energy-related CO_2 emissions when the manufacture of materials is included (UNEP, 2022). The literature separates two kinds of impact which are the operational impact and the embodied impact. The operational impact is the energy and water a building uses over its life for cooling, heating, lighting and appliances, whereas embodied impact is the emissions and resources used in extracting, making, transporting and assembling materials for the construction. Cement alone produces 8% of global CO_2emissions (Lehne & Preston, 2018). As buildings have become more efficient to use, attention has shifted from operational impact to embodied impact in recent years.

Therefore, sustainability in buildings is measured across the whole life cycle which is from site selection and design, through materials and construction, to decades of operation and eventual demolition. In India specifically, this is important because much of the future building stock is still

to be built, as it is a developing country. Decisions made now will lock in water use, emissions and systems for years to come. India's commitments under the Paris Agreement, including net-zero emissions by 2070 and its Mission LiFE campaign for sustainable lifestyles, both depend on how this new floor area is designed and built (PM India, 2022).

2.2 What makes a building material "sustainable"

A building material is sustainable when it lowers environmental harm across its life cycle of extraction, manufacture, transport, use and disposal. The literature usually judges materials on embodied carbon which includes the energy and water used in production, use of waste or recycled inputs, durability and if they can be sourced locally.

However, cement and steel are the largest concerns. A work by Development Alternatives found that the construction sector produced 22% of India's CO_2 emissions, with 80% of that coming from four energy-intensive materials: cement, steel, bricks and lime (Development Alternatives, 1997). Similarly, an analysis by RMI prioritised cutting embodied carbon from steel and cement alongside emissions from space cooling (Mendonca, 2025).

The table below presents the sustainable alternatives discussed in Indian practice.

Table 1: Common sustainable building materials in India

Material	Replaces	Main environmental benefit
Limestone Calcined Clay Cement (LC3)	Ordinary Portland cement	Up to 40% lower CO2; calcined at about 800°C instead of 1,450°C
Fly ash cement and fly ash bricks	Portland cement, fired clay bricks	Reuses thermal power plant waste; avoids topsoil use for bricks
Autoclaved aerated concrete (AAC) blocks	Fired clay bricks	Lighter, better insulation, lower cooling demand
Recycled and low-carbon steel	Virgin steel	Lower energy per tonne
Bamboo and engineered timber	Steel, concrete in light structures	Renewable, stores carbon
High-performance glazing and insulation	Single glazing, uninsulated walls	Cuts heat gain and cooling load

Sources: LC3 figures from Global Cement (2025) and Infrastructure Today (2025); other rows compiled by the author

LC3 is especially relevant as it was developed over a decade by IIT Delhi, IIT Madras, EPFL (Switzerland), Universidad de las Villas (Cuba), TARA and Swiss Development Cooperation. It is reported to cost 25% less to produce than conventional cement while delivering comparable strength (Global Cement, 2025).

2.3 Green buildings and rating systems

Sustainable materials are not the only measure for considering a building a green building. Other factors include site selection, passive design (daylight, natural ventilation, shading), energy and water efficiency, renewable energy, waste management and indoor air quality. As an IGBC representative in Uttar Pradesh has stated, “a green building is a process rather than a product,

starting from site selection and design through to materials, efficiency and renewable resources" (Realty n More, 2022a). Formally, India has three major rating systems:

1. **IGBC (Indian Green Building Council):** This was set up by the Confederation of Indian Industry in 2001. It runs 32 rating systems, and 90% of India's green building projects use them (The Machine Maker, 2026).
2. **GRIHA (Green Rating for Integrated Habitat Assessment):** India's national rating system which was developed with TERI and the Ministry of New and Renewable Energy and is widely used for government buildings (GRIHA Council, n.d.).
3. **LEED (Leadership in Energy and Environmental Design):** The US Green Building Council's international system, common for corporate and foreign-funded projects (U.S. Green Building Council, n.d.).

This green building movement is on a rapid rise. IGBC's registered footprint initially rose from 6.40 billion sq ft across 4,700 projects in October 2018 and then to 16.33 billion sq ft across 20,012 projects by 2026 (The Machine Maker, 2026).

Table 2: IGBC-registered green building footprint in India, 2018–2026

Reported	Footprint (bn sq ft)
Oct 2018	6.40
Oct 2022	9.75
Nov 2023	9.88
Mar 2025	13.20
Nov 2025	14.80
2026	16.33

Sources: IGBC figures as reported in Business Line (n.d.), Realty n More (2022b), The Machine Maker (2025, 2026) and other IGBC news releases

The footprint has more than doubled since 2018, from 6.40 to 16.33 bn sq ft, which is about 13% a year.

The compound annual growth rate (CAGR) is 13%, a pace that puts India well ahead of IGBC's "50@50" goal of 50 billion sq ft by 2050 (Realty n More, 2022c) and would need only 4.8% growth a year from 2026.

Uttar Pradesh ranks second nationally in green building footprint (CB Insights, n.d.). The table below breaks down North India's footprint and adds a calculated average project size.

Table 3: IGBC-registered green building footprint in North India

Region	Registered projects	Footprint (bn sq ft)	Average project size (million sq ft)
NCR (total)	2,475	2.81	1.14
Uttar Pradesh (state total)	1,673	1.78	1.06

Noida and Greater Noida	748	0.83	1.11
Gurugram	651	0.71	1.09
Delhi	794	0.63	0.79

Source: CB Insights (n.d.), summarising IGBC data. Average project size = footprint ÷ registered projects

This shows that 47% of Uttar Pradesh's green footprint is solely from Noida and Greater Noida which means that green construction in the state is concentrated around the Jewar airport region. Uttar Pradesh's 1.78 billion sq ft is 11% of the national total of 15.74 billion sq ft reported at the same time.

2.4 Green infrastructure beyond buildings

Most studies focus on offices and housing whereas large infrastructure such as airports, metro systems and highways is less studied, despite using vast amounts of cement and steel and running for decades. Internationally, the Airports Council International's Airport Carbon Accreditation scheme sets the levels from mapping emissions to net zero (Atrius, 2025). In India, airports in major cities such as Delhi, Bengaluru, Hyderabad and Kochi have adopted solar power and carbon accreditation. However, a greenfield airport designed as net zero from the start has been rare (The Week, 2026; Suchitra, 2024).

3. Research gap and methodology

The attempt of this paper is to bring out the importance and the current use of sustainable building materials. It emphasises on "green projects" that help in achieving sustainability. What would the viability of such projects be for the builder and for the buyer? What steps have the central and state governments in India taken to address this concern? A case study of Jewar airport in UP is taken to understand the process, procedures and the encouragement to address the above concerns. The methodology adopted would be of the mixed method type where both qualitative and quantitative data from authentic sources will be analysed to understand the above questions.

4. Analysis: How Noida International Airport at Jewar Was Built

This section analyses Phase 1 of Noida International Airport (NIA) at Jewar with respect to planning, design and construction, and the extent to which sustainability was considered at every stage. The process involved project documents, contractor reports and news coverage along with the researcher's calculations to understand the extent to which sustainability was embedded at every stage of development.

4.1 The project at a glance

The airport was designed as a greenfield project which meant that it was built on open farmland rather than the expansion of the existing airport facilities (Construction World, 2026).

Table 4: Noida International Airport, Phase 1 at a glance

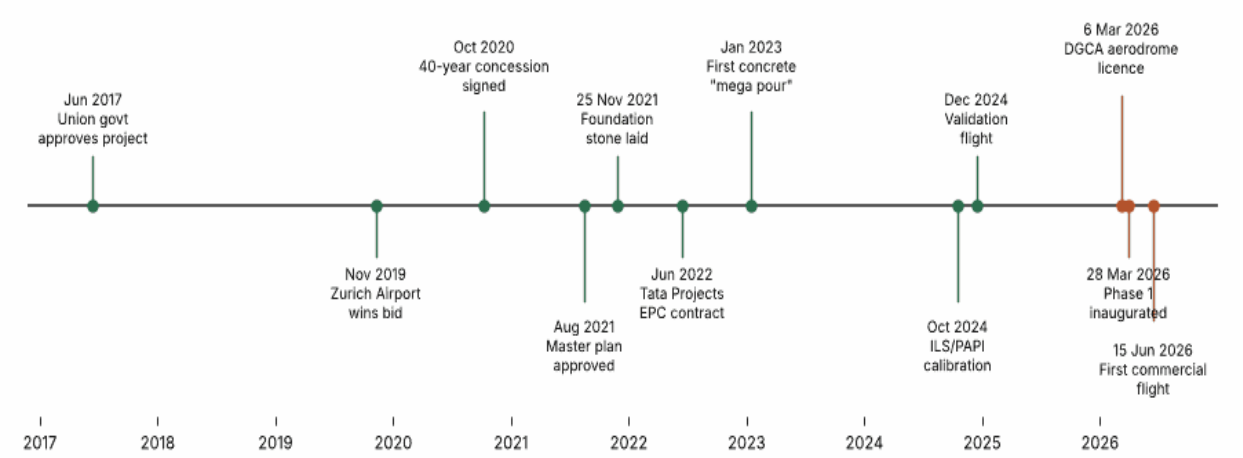
Details	Type
Owner	Government of Uttar Pradesh, through Noida International Airport Ltd*
Developer and operator	Yamuna International Airport Pvt Ltd (YIAPL), a wholly owned subsidiary of Zurich Airport International AG**
Contract model	Public-private partnership; 40-year concession, 2021–2061***
Construction (EPC) contractor	Tata Projects Ltd; letter of intent signed June 2022***
Terminal architects	Nordic Office of Architecture, Grimshaw and Haptic, with STUP****
Water systems design	Ramboll India*****
Phase 1 land	About 1,334 hectares******
Phase 1 investment	About ₹11,200 crore (Rs 112 billion)******
Runway	One runway, 3,900 m, designed to CAT III and ICAO Code F standards (all-weather, wide-body aircraft)***
Terminal 1	101,590 sq m in the master plan; about 138,000 sq m reported by the contractor***/*******
Aircraft stands	28***
Peak runway capacity	30 flights per hour*******
Passenger capacity	12 million passengers a year (Phase 1)*******
Passenger facilities	48 check-in counters (20 self bag-drop), 9 security lanes, 10 passenger boarding bridges*******
Cargo terminal	About 80,000 sq m, 250,000 tonnes a year initially, built by Air India SATS*******

Sources: *Wikipedia contributors (2026); **Construction World (2026); ***Noida International Airport (2023); ****Airport Technology (2024); *****Bentley Systems (2022); ******Rai (2026a); *******Tata Group (n.d.).

4.2 Second stage: from approval to first flight: the timeline

The airport took about nine years from Union government approval in June 2017 to its first commercial flight on 15 June 2026 (Wikipedia contributors, 2026). Figure 1 sets out the main milestones.

Figure 1: Timeline of the Noida Airport, from approval to first flight



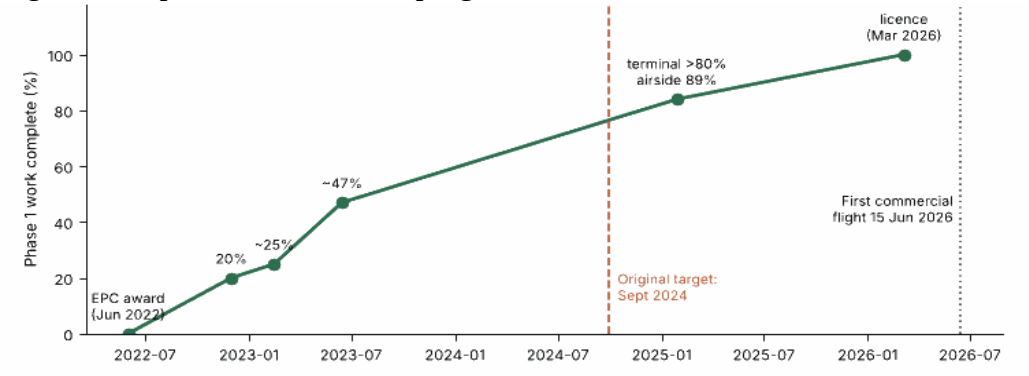
Sources for Figure 1: Wikipedia contributors (2026); Noida International Airport (2023); Rai (2026a); Mishra (2023a); News On AIR (2026a, 2026b).

The timeline mainly falls into three stages. The first (2017 to 2021) was taken up by approvals and contracts: Zurich Airport International won the bid in November 2019, the concession was signed in October 2020 and the master plan was approved in August 2021 (Noida International Airport, 2023). The second stage was the physical construction (25 November 2021 to early 2026) (Rai, 2026a). This was followed by the third stage of testing and certification. In the case of the Jewar airport, this meant the instrument landing system was calibrated in October 2024, a validation flight was flown in December 2024 (Rai, 2026a), the Directorate General of Civil Aviation (DGCA) granted an aerodrome licence for all-weather operations on 6 March 2026 (News On AIR, 2026a), and commercial flights began on 15 June 2026 (News On AIR, 2026b). Therefore, construction, from the foundation stone to the inauguration, took about 52 months.

4.3 How construction progressed

Construction progress can be tracked using figures reported at different dates (Figure 2). By December 2022, Phase 1 was about 20% complete, with a 17 km boundary wall and an electrical substation finished (Bhowmik, 2023). It was nearly 25% complete by February 2023 (Mishra, 2023b) and about 47% complete by June 2023 (Mishra, 2023d). By January 2025, the terminal was more than 80% complete, airside works 89% and landside works 79%, with Rs.9,024 crore of a sanctioned Rs.10,056 crore spent (Nimje, 2025).

Figure 2: Reported construction progress of Phase 1, 2022–2026



Sources for Figure 2: Bhowmik (2023); Mishra (2023b, 2023d); Nimje (2025); News On AIR (2026a, 2026b). The January 2025 point is plotted at about 84%, the midpoint of the reported terminal, airside and landside figures.

There was a delay in the project as the concession agreement required Phase 1 to be operational by September 2024 (Mishra, 2023d); however, commercial operations actually began on 15 June 2026 (News On AIR, 2026b), running 21 months behind. Progress was fastest in the early civil works: between December 2022 and June 2023, completion rose by about 4.5 percentage points a month, after which progress slowed sharply. Over the next 19 months to January 2025, completion rose only to around 84%, about 2 points a month ((84 − 47) ÷ 19). This is common in large projects, where earthwork and concrete are done quickly, but installing systems, testing and getting regulatory approval take longer. Spending was almost complete by early 2025, at about 90% of the sanctioned amount (9,024 ÷ 10,056) (Nimje, 2025). One possible reason for the delay was the time taken for acquisition of land.

4.4 The scale of construction

The table below brings together the reported figures on labour, machinery and materials.

Table 5: Construction inputs at Jewar, Phase 1

Indicator	Figure reported
Workers on site, March 2023	Over 2,600, rising to a target of about 6,000
Machines on site, March 2023	Over 400 heavy and small machines
Concrete poured by March 2023	About 32,000 cubic metres
Steel used by March 2023	About 14,000 tonnes
First "mega pour", 16 January 2023	1,800 cubic metres of concrete and 350 tonnes of cement in 20 hours
Safe man-hours	4.2 million (March 2023); over 6 million (June 2023); over 85 million (2026)
Total workforce over the project	More than 100,000 people
Boundary wall	17 km
Design documentation	95% digital

Source : Swarajya, Mar 2023;India Infra Hub, Jan 2023;Tata Group;Airport Technology, Dec 2022;NIA presentation to ICAO, 2023:

Several ratios stated above helped in achieving sustainability and following the norms laid down for green projects. The rate at which the concrete was poured was 90 cubic metres an hour (1,800 ÷ 20) and used about 194 kg of cement per cubic metre (350,000 kg ÷ 1,800). There are no authentic figures that indicate the binders that have been used in the concrete, for example the

quality of fly ash. Overall, 85 million man-hours shared among more than 100,000 workers led to about 850 hours per worker, or roughly 106 eight-hour days. This suggests that the project did not have a fixed team and instead had a large workforce that kept changing. Man-hours employed increased from 4.2 million in March 2023 to over 85 million by 2026, indicating that 95% of all labour ((85 − 4.2) ÷ 85) came after the first year of building, during the structural, systems and fit-out stages.

4.5 How sustainability was built in during construction

Sustainability at Jewar was applied during the construction process itself, as shown in the table below.

Table 6: Sustainable construction practices at Jewar

Area	What was done
Cement (LC3)	First large-scale use of limestone calcined clay cement in India, in the runway and one building complex
Cement (fly ash)	Fly ash cement used in place of ordinary Portland cement in concrete
Concrete additives	Nanotechnology admixtures (Nanogence) to improve durability and cut cement-related emissions
Sand	Manufactured sand from stone and granite by-products, replacing 80–100% of river sand in concrete
Water during building	Curing compounds and admixtures to save curing water; treated sewage water used for dust control through mist guns and sprinklers
Rainwater	Two rainwater harvesting ponds on the east and west of the site
Water systems	Integrated water, wastewater and stormwater network; designed to cut demand for outside water by 90,000 cubic metres a year
Wastewater	Zero-liquid-discharge sewage treatment plant
Energy	13 MW on-site solar and 10.8 MW of wind power contracted with Tata Power
Lighting and monitoring	Smart lighting with motion sensors; sensors for particulate matter, VOCs and NOx
Vehicles	EV charging for airside vehicles; all-electric taxi fleet
Trees	Tree transplantation and planned green areas across the campus

Sources: Global Cement (2025); Infrastructure Today (2025); Noida International Airport (2024, 2025); Business Today (2026); Rai (2026b); Mathew (2026); Bentley Systems (2022).

The most important of these measures were the material choices as cement and steel carry a large amount of carbon. Using LC3 cement and fly ash cement along with the manufactured sand resulted in reduction of emissions from cement and reduced the pressure on river sand mining simultaneously. Along with this the savings on water were also immense: approximately 90,000 cubic metres a year was saved by the water system design that is equal to about 36 Olympic swimming pools (90,000 ÷ 2,500, author's calculation).

The contracted renewable capacity was converted into annual output and avoided emissions using the following formula:

energy (MWh) = capacity (MW) × 8,760 hours × capacity factor (author's calculation).

Solar: 13 MW × 8,760 × 18% ≈ 20,498 MWh.

Wind: 10.8 MW × 8,760 × 30% ≈ 28,382 MWh.

These calculations result in a saving of about 48,880 MWh a year. Using India's grid emission factor of 0.727 tonnes of CO_2 per MWh (BidDetail, n.d.), this avoids about 35,500 tonnes of CO_2 emissions in a year. The capacity factors of 18% and 30% are assumptions, as this capacity is expected to meet only about half of the airport's power needs (Mathew, 2026); the other half still comes from the grid.

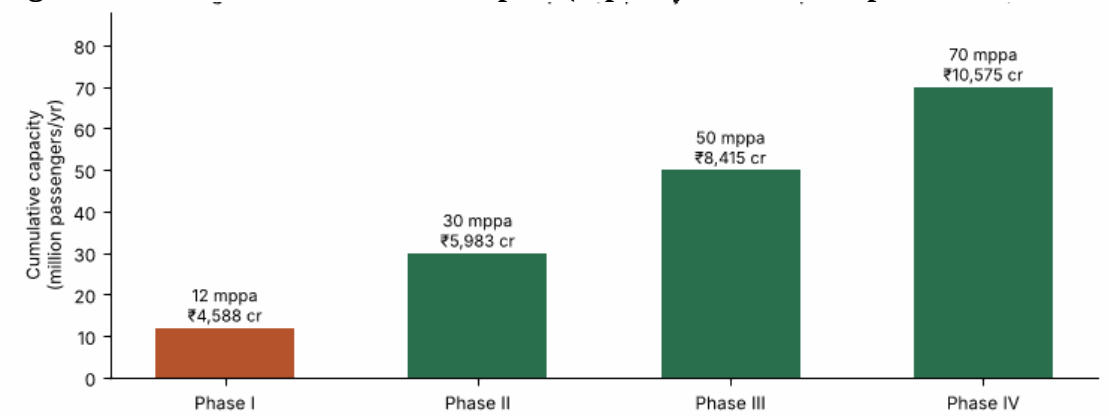
4.6 Design: building for the local climate

The terminal was designed to be carbon net zero and to achieve LEED Gold certification and targeted four IGBC ratings (Block, 2020; Jacobs, n.d.). Its main feature is a landscaped internal courtyard that is inspired by the traditional haveli, which brings daylight and natural ventilation deep into the building and reduces the need for artificial lighting. The terminal also has high ceilings, a wavy roofline inspired by the Yamuna river and interiors that use regional art, textiles and handicrafts (Airport Technology, 2024; Domus, 2023).

4.7 Building in phases

The airport is not being built all at once. It is planned in four phases, growing from 12 million passengers a year in Phase 1 to 70 million passengers at its maximum capacity.

Figure 3: Phased build-out of the airport (capacity and YEIDA phase cost estimates)



Sources for Figure 3: capacities from Noida International Airport (2023); phase cost estimates from YEIDA [reference to be added].

Table 7: Phase 1 compared with full build-out (Phase 4)

Item	Phase 1	Phase 4 (full build-out)
Passenger capacity	12 million a year	70 million a year
Aircraft movements a year	96,400	489,700
Cargo (tonnes a year)	249,600	1,129,400
Runways	1 (3,900 m)	2 (3,900 m and 4,150 m)
Aircraft stands	28	186
Passenger terminal area	101,590 sq m (Terminal 1)	488,000 sq m (Terminals 1 and 2)
Fuel storage	3 × 3,300 cubic metres	8 × 6,000 cubic metres

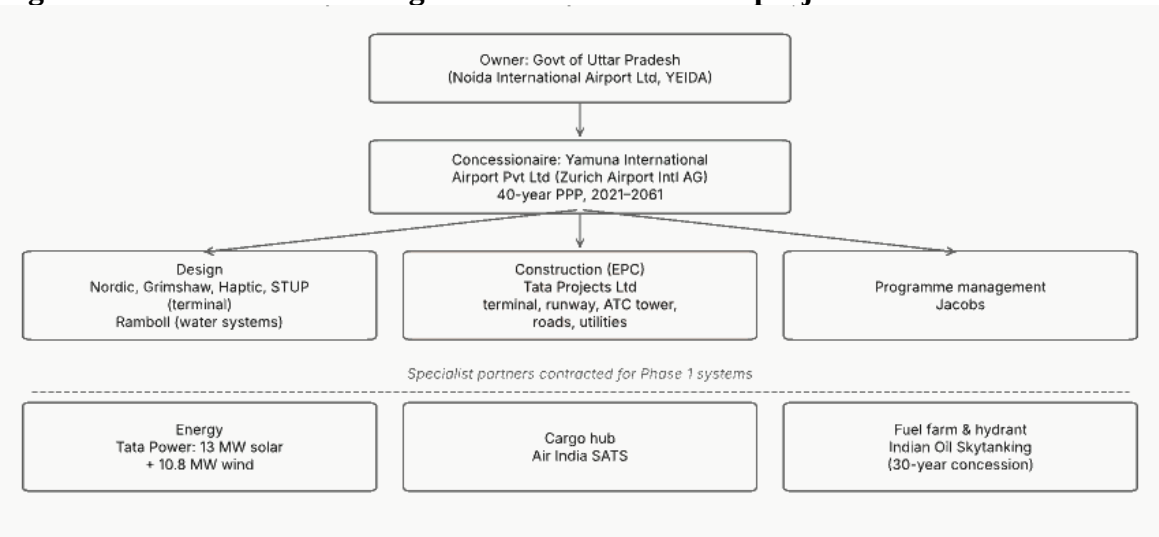
Source: Noida International Airport (2023)

Building in phases has clear advantages for sustainability and viability. Cement and steel will only be used as passenger demand grows. Phase 1 gives 8,466 sq m of terminal per million passengers while full build-out comes to 6,971 sq m, which is 18% less space per passenger. Using YEIDA's estimates, the cost of each additional million passengers of capacity is ₹382 crore in Phase 1, ₹332 crore in Phase 2, ₹421 crore in Phase 3 and ₹529 crore in Phase 4. However, YEIDA's Phase 1 estimate of ₹4,588 crore is much lower than the investment reported for Phase 1, which is ₹11,200 crore (Rai, 2026a).

4.8 Analysis of how the various parts of airport building were divided

The figure below shows how responsibilities were divided among the main organisations. The state owns the airport and the private concessionaire designs, finances, builds and operates it. Tata Projects' EPC covered the terminal, runway, airside and landside infrastructure, roads, utilities, cargo terminal and air traffic control tower (Construction World, 2026).

Figure 4: Who built what – organisation of the Phase 1 project



Sources: Wikipedia contributors (2026); Construction World (2026); Airport Technology (2024); Bentley Systems (2022); Jacobs (n.d.); Noida International Airport (2023); Tata Group (n.d.); Rai (2026a).

4.9 Key conclusions

It was a long structured process that took nine years from approval to first flight, of which about 52 months was construction. Commercial operations began about 21 months after the September 2024 deadline in the concession agreement, the main reason being the delay in the completion of civil work. More than 100,000 workers and over 85 million safe man-hours went into Phase 1. Low-carbon cement (LC3 and fly ash), manufactured sand, water-saving curing, rainwater harvesting and a zero-liquid-discharge treatment plant show that green principles were applied on site. The contracted 23.8 MW of solar and wind is expected to meet half of the energy demand. A net zero goal depends on adding more renewable power. A complete analysis was not possible due to gaps in published data; for example, no data is available on the quality of concrete, steel and LC3.

5. Limitations

The main limitation was the use of only secondary data, as site visits and interviews with all stakeholders were not possible due to a paucity of time and finance. There were areas where complete data of material used was not available. At times, conflicting data sets were discovered while working with the available information. A large amount of information was gathered from newspaper reports. The information on sustainable construction material and practices could only be sourced from the developer, contractor and suppliers. There was no independent study in this regard.

6. Conclusion and the Way Ahead

The viability of Jewar airport being a "green project" was definitely defined and adhered to in the first phase of the project. The decision to increase facilities as and when the capacity increases defined the adherence to sustainable practices. It is extremely important to encourage green projects in the realty sector so that the detrimental effects of climate change can be attempted to be reduced.

Given that there is an imminent possibility of increased construction of infrastructure in India, the conditions set out for green projects should become mandatory for any future construction. As India is a developing country, the requirement for infrastructure growth is exponential. It thus becomes essential for all authorities to ensure that green projects are encouraged and sustainable practices are maintained. This should begin right from the inception stage to conclusion. This has definitely been taken into account in the building of the Jewar airport in Noida, UP.

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