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# UNDERSTANDING DESIGN CONSIDERATIONS FOR FISH HARBOUR

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*Abstract:* Fish harbour play a crucial role in facilitating the fishing industry's operations, serving as vital hubs for landing, processing, and distributing seafood products. Efficient design considerations are paramount to ensure the functionality, sustainability, and safety of these harbour. This research paper aims to provide a comprehensive understanding of the key design considerations for fish harbour, encompassing various aspects such as infrastructure, environmental factors, technological advancements, and socio-economic impacts. The research is conducted to understand design considerations to build a fish harbour and assess the impact of a fishing harbour on fishermen's livelihoods through an extensive review of literature, case studies, and expert opinions. The research paper concludes by explaining how the design considerations for fish harbour is understood with respect to shapes and sizes of the harbours' architectural elements, 2d & 3d designs, eye catchy or tourist attractive focal points, landscaping and sustainable features etc.

*Keywords* - Fishing, Fish Harbour, Fishermen, Import & Export, Fish Market, Infrastructure, Environmental Impact.

## I. INTRODUCTION

The coastline of the world typically ranges from around 356,000 to 372,000 kilometres (221,000 to 231,000 miles) (according to world factbook). The number of people who depend on coastal areas for their livelihoods is significant and continuously changing due to factors such as population growth, urbanization, and economic development. Coastal areas provide various resources and opportunities for livelihoods, including fishing, tourism, shipping, trade, and agriculture.

As of January 2022, data indicates that around 40% of the global population resides within 100 kilometers (62 miles) of a coastline, with many relying directly or indirectly on coastal resources for their livelihoods. India boasts an extensive coastline stretching over 8,000 kilometers and an Exclusive Economic Zone (EEZ) surpassing 2 million square kilometers, placing it 18th globally in terms of coastal expanse. With abundant freshwater reservoirs complementing its coastal riches, India's fisheries sector plays a vital role in its socio-economic fabric.

Approximately 250 million individuals in India inhabit areas within 50 kilometers of the country's coastline, spanning nine states and two union territories. This coastal belt encompasses 77 towns and cities, including major urban centers like Mumbai, Kolkata, and Chennai. Employment opportunities in the fisheries sector are abundant, with millions finding work directly or indirectly, thus contributing significantly to the nation's food security.

Presently, fisheries and aquaculture in India contribute 1.07% to the national GDP. Marine fisheries, in particular, are crucial for food security and provide direct employment to over 1.5 million fisherfolk, supporting countless others indirectly. According to the CMFRI Census 2010, there are 3,288 villages dedicated to marine fishing activities, alongside 1,511 designated marine fish landing centers across nine maritime states and two union territories. The marine fishing community comprises approximately 4 million individuals across 864,550 families, with nearly 61% falling under the Below Poverty Line (BPL) category.

"Fishing" refers to the activity of catching fish and other aquatic organisms from freshwater or marine environments for various purposes, such as food, income generation, or trade. Fishing can involve various methods, including traditional methods like net fishing, hook and line fishing, or modern methods such as trawling, purse seining, and aquaculture. Fishing communities often rely on this activity as their primary source of income and sustenance, contributing to the economy and food security of coastal regions worldwide.

The fisherman community living near the sea, having their main occupation as fisherman are a part of our culture since many years and have been a part of oldest occupation in the history of mankind.

West Bengal, Andhra Pradesh, and Gujarat emerge as the foremost fish-producing states in India. Presently, the total fish production stands at 10.07 million metric tonnes, with the inland sector and culture fisheries contributing nearly 65% each.

The traditional occupation of fishing, rooted in antiquity, faces diminishing significance inn contemporary times due to shifts towards low-maintenance lifestyles and the absence of stable income streams. The sense of self belonging and pride is missing which has led to fall of market and the culture of the community.

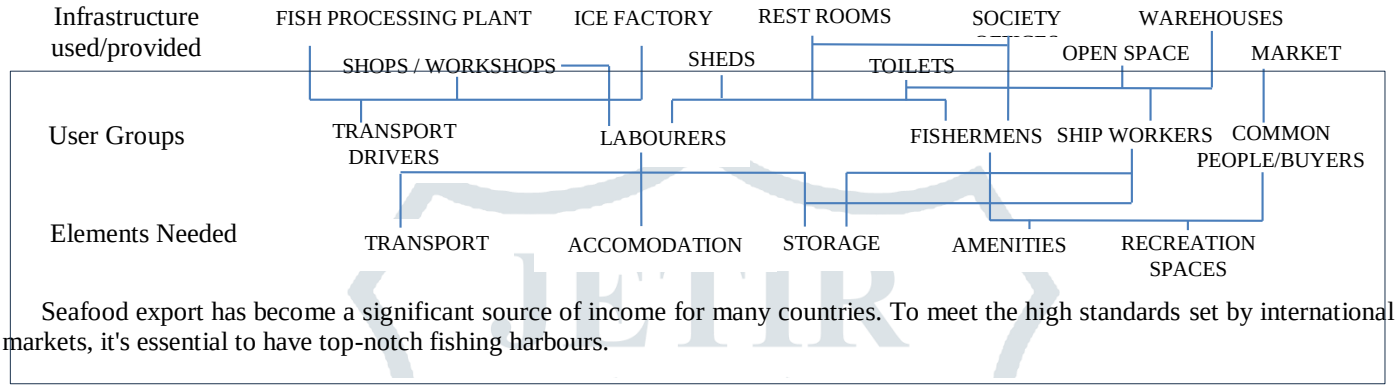
As of 2020, the Indian seafood market demonstrated robust growth, reaching a valuation of USD 9.6 billion. Projections suggest a promising Compound Annual Growth Rate (CAGR) of 10.2% from 2021 to 2026. This positive trajectory is driven by various factors, such as increasing domestic consumption, expanding export avenues, favourable government initiatives, and a growing acknowledgment of the health benefits linked with seafood consumption.

A fish harbour is like a busy meeting place where fish, people, and fishing gear all come together. It's where fishermen bring their catch, buyers come to purchase fish, and various services related to fishing are provided. Both government and private organizations are involved in managing the harbour. It's also where fish caught by fishermen are turned into products for trade.

In a fishing harbour, you'll find a mix of people and activities like nowhere else in the fishing industry. It's a great opportunity to encourage responsible fishing practices, like reducing waste and keeping fish fresh. The way a fishing harbour is kept can affect not only the health of people and the environment but also the prices of fish and how much gets exported.

Having the right buildings and facilities in the right place is crucial for a fishing harbour to work well. But just as important is how it's looked after and run. Everyone involved, from fishermen to government officials, plays a key role in keeping the harbour sustainable and thriving.

Fish marketing faces unique challenges, including unpredictable fish production, the quick spoilage of fish, gathering fish from various fishing centres, dealing with a wide variety of fish species and demand patterns, frequent and drastic price changes, challenges in matching supply with demand, and the necessity for specialized transportation methods for fish.

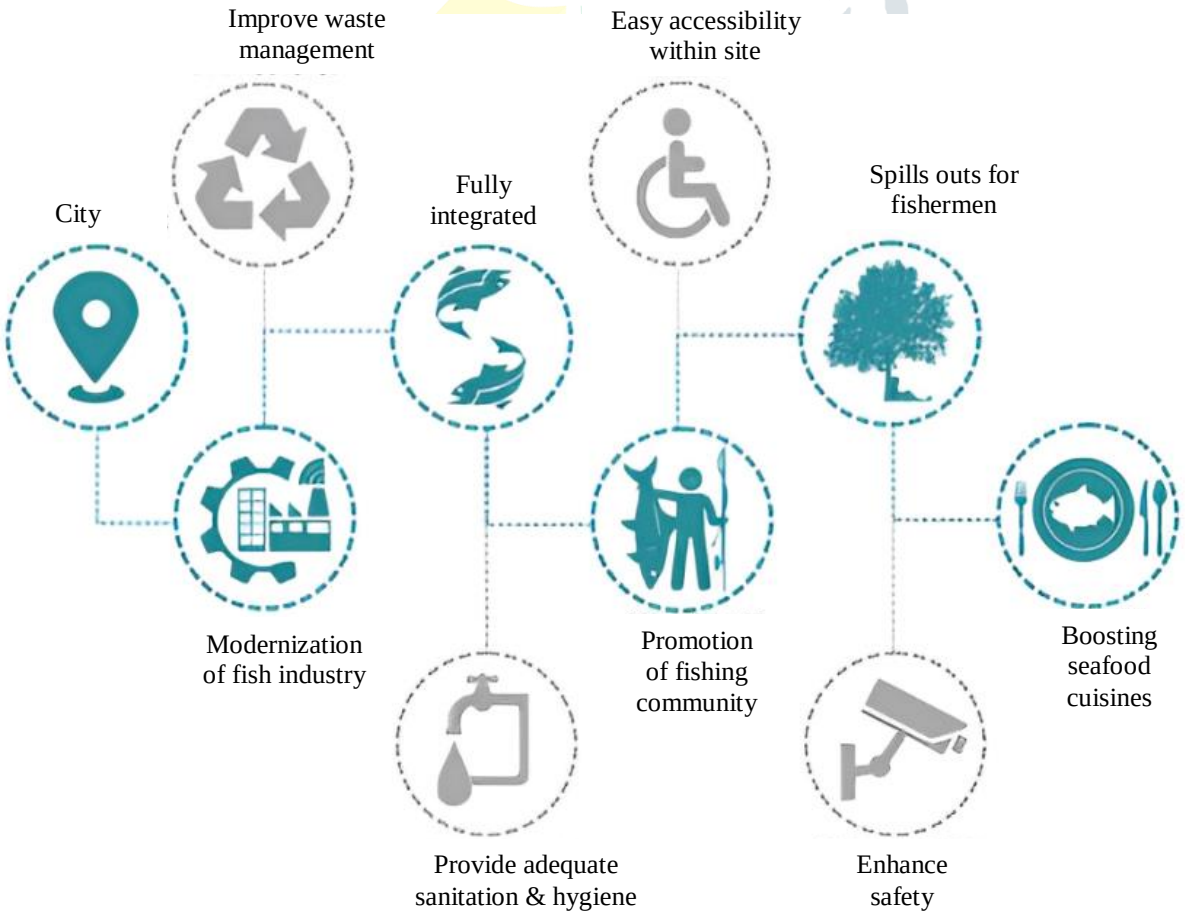



Seafood export has become a significant source of income for many countries. To meet the high standards set by international markets, it's essential to have top-notch fishing harbours.

Fig 1. Relation between Infrastructure, users & elements.

### 1.1 Need for the Fishing Harbour

The traditional fishing occupation, once esteemed as one of the oldest and most respected livelihoods, is experiencing a decline in significance amidst modern lifestyles characterized by minimal maintenance and uncertain incomes. This shift has eroded the sense of identity and pride within fishing communities, resulting in a downturn in market demand and cultural vitality.




Despite India's significant standing as the world's third-largest fish-producing nation, contributing 8% to global fish production and ranking second in aquaculture output, there remains a notable gap in the recognition and support extended to the fishing community.

Fig 2. Fundamental aspects of Fish Harbour

The Harbour will provide proper amenities to the people involve in fishing and fishing related activities which will help them to boost their income and live healthy life. So, finalizing the aim & objective –

### 1.2 Aim & Objectives

The aim of the harbour is sustaining fishing as an occupation & to create sustainable environment for the fishing community.

- The objective is to understand a comprehensive assessment and organization of dispersed areas, with the aim of establishing a cohesive infrastructure comprising a fish port, transportation facilities, markets, educational halls, kinder garden, clinic, etc.
- To study about how to improve hygiene of the area.
- To study about how to improve income of small fisherman, through the provision of services and facilities which add to the value of their produce.
- To study about proper infrastructure will all the amenities and provision of modern technologies.
- To understand about the development of community, culture and economy.
- To study about sustainable materials, forms & techniques so that the harbour should not have negative impact on the surrounding thus creating the sustainable environment.

## II. STANDARDS AND REQUIREMENTS

We have tried to collect data from certain standards like Neuferts, DCR, Time Savers.

**2.1 Spaces** that should be provided in the fish harbour to make it properly functionable are as follow –

#### 2.1.1 Ship and Boat Docking Jetties

Minimum width of the jetty should be of 9m & the entrance channel should be of minimum 30 m.

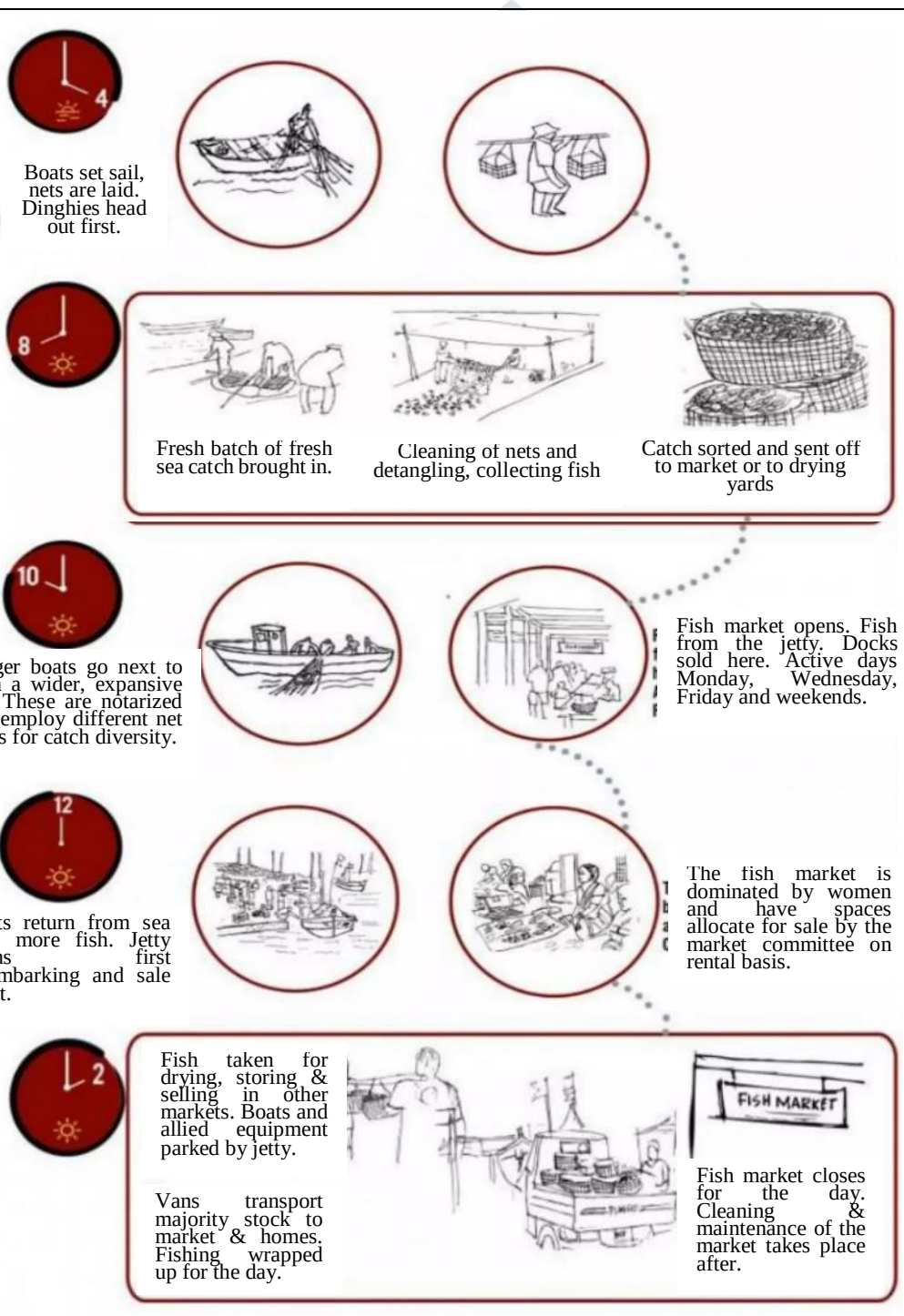
#### 2.1.2 Import & Export Hub

This is the main part of the harbour. As maximum income is generated from import and export of the seafood.

Table 1 – Requirements and standards of import and

export hub (Source - Neuferts)

Fig 3. Fishing Ecosystem

| Amenities of import & export hub | Sizes |
|---|---|
| Unloading area | parking space for trucks. |
| Sorting table area | 1.5mx0.4m / table+ circulation space |
|  <br>Weighing | 1.5x1.5m+ circulation space |
| Display and auction area | 4mx1m / table + circulation space |
| Seating space for buyers | 0.5 sq.m/ buyer |

| | |
|---|---|
| Office | 10 sq.m |
| Loading bay | |

| | |
|---|---|
| Superintendent of fisheries- 1 | Assistant superintendent of fisheries- 1 |
| Fisheries officer-1 | Patrol sergeant- 1 |
| Patrol man- 1 | Head clerk- 1 |
| Senior clerk- 1 | Accountant-1 |
| Junior clerks-3 | Peon-1 |
| Watchmen-1 | Sweeper-1 |

**2.1.3 Market**

When conceptualizing retail outlets, it's essential to adhere to all national regulations, encompassing aspects such as building and planning, fire safety, and health and safety standards at the workplace.

Table 2 - Recommended dimensions for vertical spaces within commercial establishments (Source: Studedu)

| **Sizes** | **Heights** |
|---|---|
| 400 sq.m | 3.00m |
| Over 400 sq.m | 3.30m |
| Over 1500 sq.m | 3.50m |

Delivery platforms should be 1.10 m -1.20 m above ground level.

Table 3 - Amenities of market required

| | |
|---|---|
| 1. Cold room | 6. Warehouse area |
| 2. Frozen food storage | 7. Fire exit |
| 3. Roller shutter | 8. Bulk store |
| 4. Raw wash up | 9. Office |
| 5. Toilets | 10. ATM |

**2.1.4 Cold and Dry Storage for fishes**

Fresh fish can maintain quality when stored on ice at a temperature of 272.15 K, with a relative humidity ranging between 90-100%, for a period of 7 days. Each fish crate, measuring 90x50x35 cm with a capacity of 50 kg, occupies 350 cubic meters of space.

**2.1.5 Public Toilets**

A fundamental aspect of fishery harbor design involves incorporating a dedicated toilet block equipped with amenities such as water closets and bathing facilities. Standard provisions for accommodating approximately 100 individuals include 7 bathing areas, 16 wash basins, 6-8 water closets, and 8 urinals.

Table 3 - Minimum spaces required for the following requirements of toilets (Source: Neuferts)

| **Amenities** | **Standards** |
|---|---|
| Lockers | 0.5x0.32x0.32 |
| Changing space | 0.5 sq.m / person |
| Circulation rout | 2.2m-2.4m |
| Dormitories | 2.32 sq.m / person |

**2.1.6 Parking**

For every 100 sq.m. 3 car & 4 bike should be provided in case of public building.

**2.1.7 Fishery administration office**

The Fisheries Department appoints a competent officer along with an adequate team to oversee the management and upkeep of the fishery harbor. Their responsibilities include overseeing activities such as fish handling, auctioning, monitoring fish prices, and managing vessel traffic entering and exiting the harbor.

Table 4 - Number of people required to manage the harbour

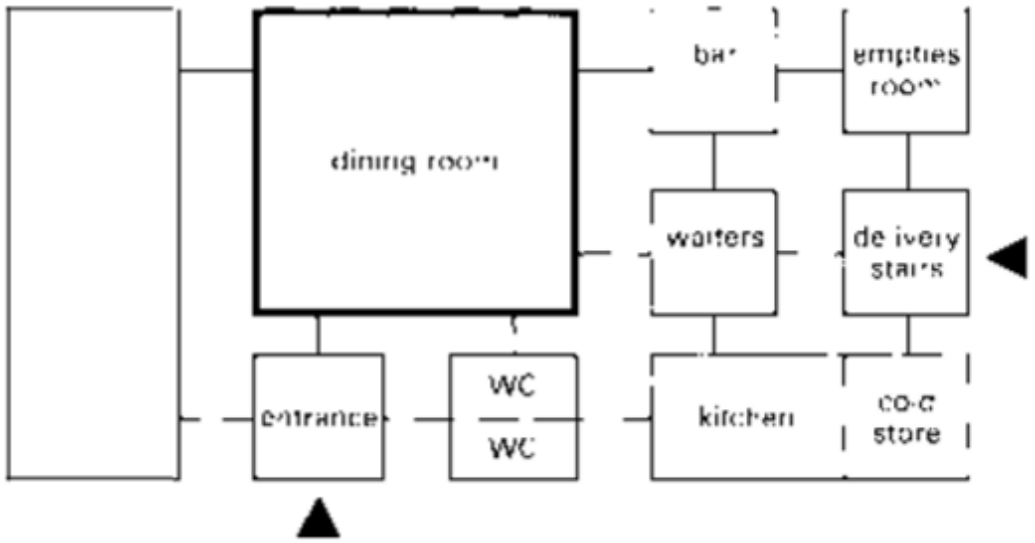
### 2.1.8 Restaurant and Bar

For a seaside establishment serving fishermen, harbor office staff, and daily visitors, the layout includes designated areas for kitchen activities, dishwashing, storage, gas service, and restroom facilities. The restaurant aims for impeccable cleanliness and hygiene, offering marine delicacies for interested patrons.

In the dining area, structural columns are strategically placed either in the center of table groupings or tucked in corners. Ceiling height standards are dictated by floor area: below 50 sqm, it's 2.50m; above 50 sqm but less than 100 sqm, it's 2.75m; and beyond 100 sqm, it's 3.00m.

In a large hotel setting, the restaurant kitchen serves as the culinary hub for multiple dining areas, accommodating up to 800-1000 diners. The kitchen layout follows a cellular system, featuring sizable appliance blocks for efficient operation.

Fig 4. Functional layout for a small restaurant (Source: Neuferts)




### 2.1.9 Hall for workshops / Meetings

Traditional fishermen are working in the fishing sector but next generation is not willing to work in this sector because private stakeholders are ruling this sector that's why wedge is very less. Also, security in the sea is the issue. New people are not willing to come in this sector because no one is providing the basic knowledge for the fresher men.

The community hall should be provided in which educational classes will be held. Training on marketing the fish will be given in this space. Also, this hall will be used for the community festivals, reception etc.

### 2.2 Planning Measures

The Department of Fisheries outlines the certification and approval requirements as follows:

Plant Location, Building, and Layout: When selecting a site for a plant, a thorough assessment of several factors is essential.

1. Primary consideration is given to the plot's size, which must accommodate current needs and allow for future expansion.
2. Proximity to public transportation, such as rail or road, is a key consideration.
3. Access to electricity, water, and steam is vital.
4. Waste disposal logistics should be integrated into the plant location planning.
5. Proper drainage is crucial in all processing areas, with slopes designed to facilitate wastewater flow. Wastewater treatment is mandatory before discharge into the community sewage system.
6. Well-designed buildings should include adequate space for work conducted under hygienic conditions, machinery and equipment storage, segregation of operations that could contaminate food, sufficient natural or artificial lighting, ventilation, and pest control measures.
7. Stringent technical regulations govern building and processing hall construction. For example, floors must withstand product spillage, water, and disinfectants while maintaining slip resistance and color retention. Designers often find selecting and preparing floors to be among the most challenging tasks.
8. Work areas should be adequately sized to facilitate hygienic processing and plant cleaning.
9. Water supply must be ample and meet processing and cleaning requirements.

10. Toilet rooms should be separate from processing areas and equipped for personal use. Light-colored tiled walls and floors are preferred.

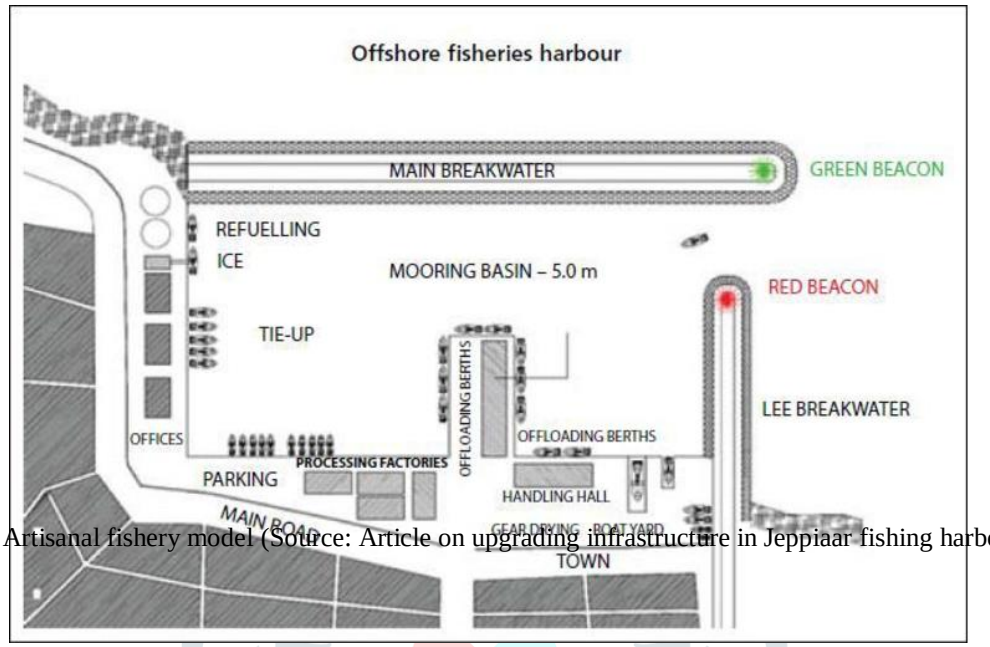



Fig 5. Artisanal fishery model (Source: Article on upgrading infrastructure in Jeppiaar fishing harbour)

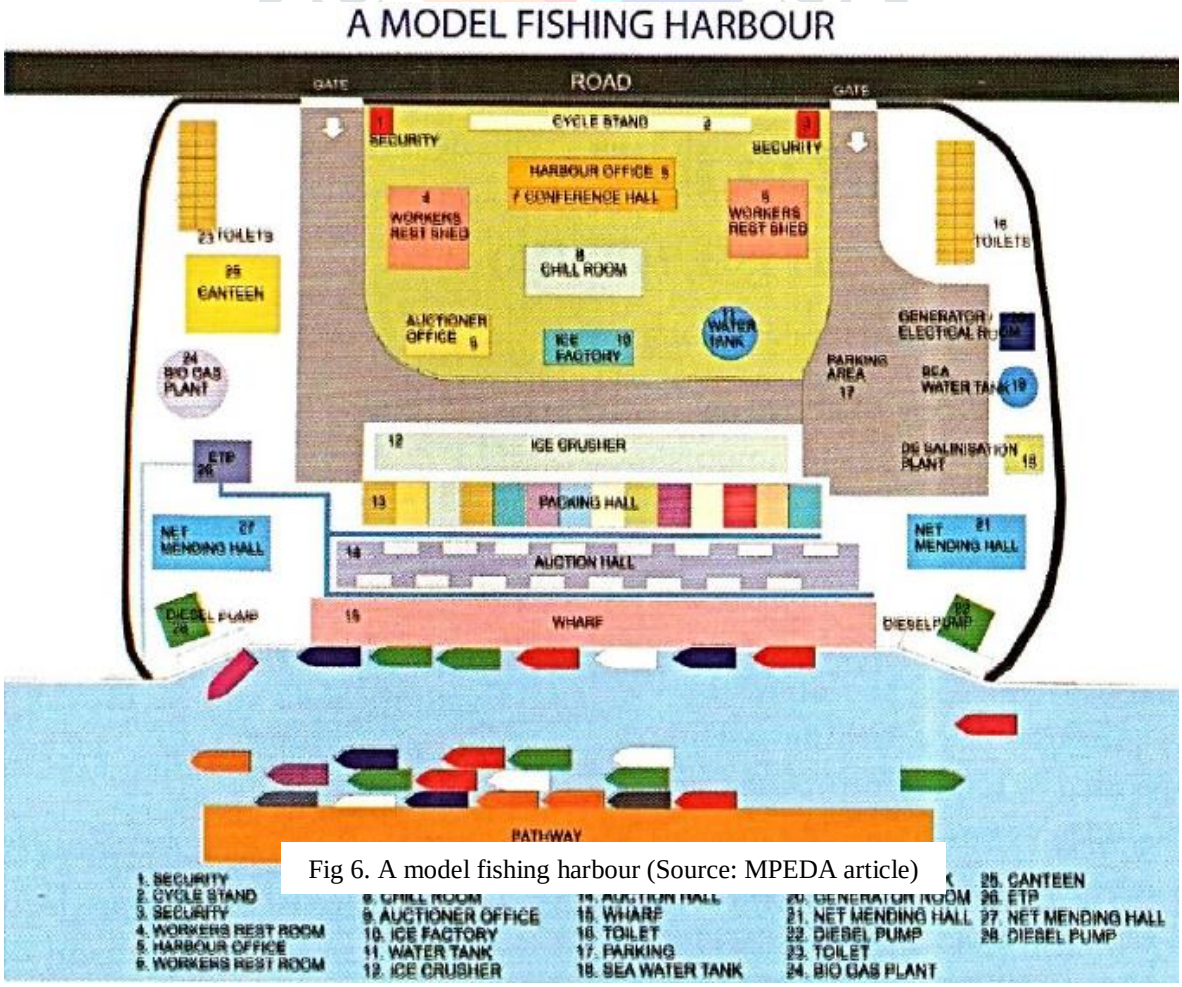



Fig 6. A model fishing harbour (Source: MPEDA article)

## III. ASSESSMENT OF IMPACTS ON ENVIRONMENT DUE TO FISH HARBOUR

### 3.1 Sustainability aspect

In today's era sustainability plays an important role. The concept of sustainable environment in fishing harbour is essential for maintaining healthy ecosystems, supporting thriving communities, and ensuring the long-term viability of fisheries for future generations. To achieve these several assessments of impact on the environment are to be done.

Drawing from the project details and the current environmental conditions, it's crucial to identify the potential impacts arising from both the construction and operation phases of the proposed project. To mitigate adverse effects, an Environmental Management Plan (EMP) has been devised, aiming to eliminate or minimize such impacts wherever feasible.

The EMP for the proposed fisheries harbour is structured across various categories:

- Land Environment
- Water Environment
- Noise Control
- Air Environment
- Ecology Impact
- Socio-Economic Environment

**3.1.1 Land Environment**

Construction Phase: No land acquisition is projected. Construction materials, such as fine and coarse aggregates, will be obtained from existing quarries.

Operation Phase: Generation of garbage and solid waste (old ropes, nets, broken fish boxes, metal items) will be managed. Offal from fish handling will be a significant source of pollution.

**3.1.2 Water Environment**

Construction Phase: Effluent impacts from labour camps and dredging may increase turbidity. Approx. 20 $m^3$/day of sewage is anticipated.

Operation Phase: Pollution sources include garbage dumping, oily beige water, and sewage disposal. Water requirements during operation are 425 $m^3$/day.

**3.1.3 Noise Environment**

Construction Phase: Noise from equipment operation may increase levels by 10-15 dB(A) at 100-200 m distances.

Operation Phase: Increased vehicular movement will be the primary noise source.

**3.1.4 Air Environment**

Construction Phase: Fugitive emissions from vehicular movement are expected but not significant.

Operation Phase: Air pollution from truck transportation of fish catch is not anticipated to be significant.

**3.1.5 Ecology Impacts**

Terrestrial Flora: There should be no forest in the surrounding area.

Marine Ecology: Dredging may disturb marine life and benthic organisms.

**3.1.6 Socio-Economic Environment**

Construction Phase: Employment for about 200 individuals expected. Positive impact on local economy.

Operation Phase: Allied activities may lead to marginal employment improvement.

**3.2 Environmental Management Plan Measures (Source: Government of Maharashtra, Commissionerate of Fisheries)**

- Provision of drinking water.
- Establishment of 20 community toilets and septic tanks.
- Placement of construction worker colonies away from sensitive areas.
- Confined construction activities like dredging.
- Safe disposal of construction waste.
- Avoidance of dredging during fish breeding seasons.
- Establishment of reception facilities for oily wastes.
- Use of mobile trawlers for collecting oily bilge water.
- Sale of spent engine oil to registered recyclers.

## IV. LEARNING FROM THE EXPERIENCES

**4.1 Primary study**

Primary study is done by live and literature case studies of fish harbour.

**4.1.1 Mangalore Harbour, Karnataka**

Around 800 boats are operated daily from this harbour. (Mogaveera community)

Location - Dhakke Parking, Bunder, Mangalore, Karnataka 575001, 12°51'20.2"N 74°50'00.6"E

Total area: 64,000 $m^2$

Mangalore harbour is situated on eastern bank of river Gurupura. Western side of the site is used for parking the boats. And all the activities like fish unloading, transporting, cleaning, selling, etc. is happen in the center of the site.

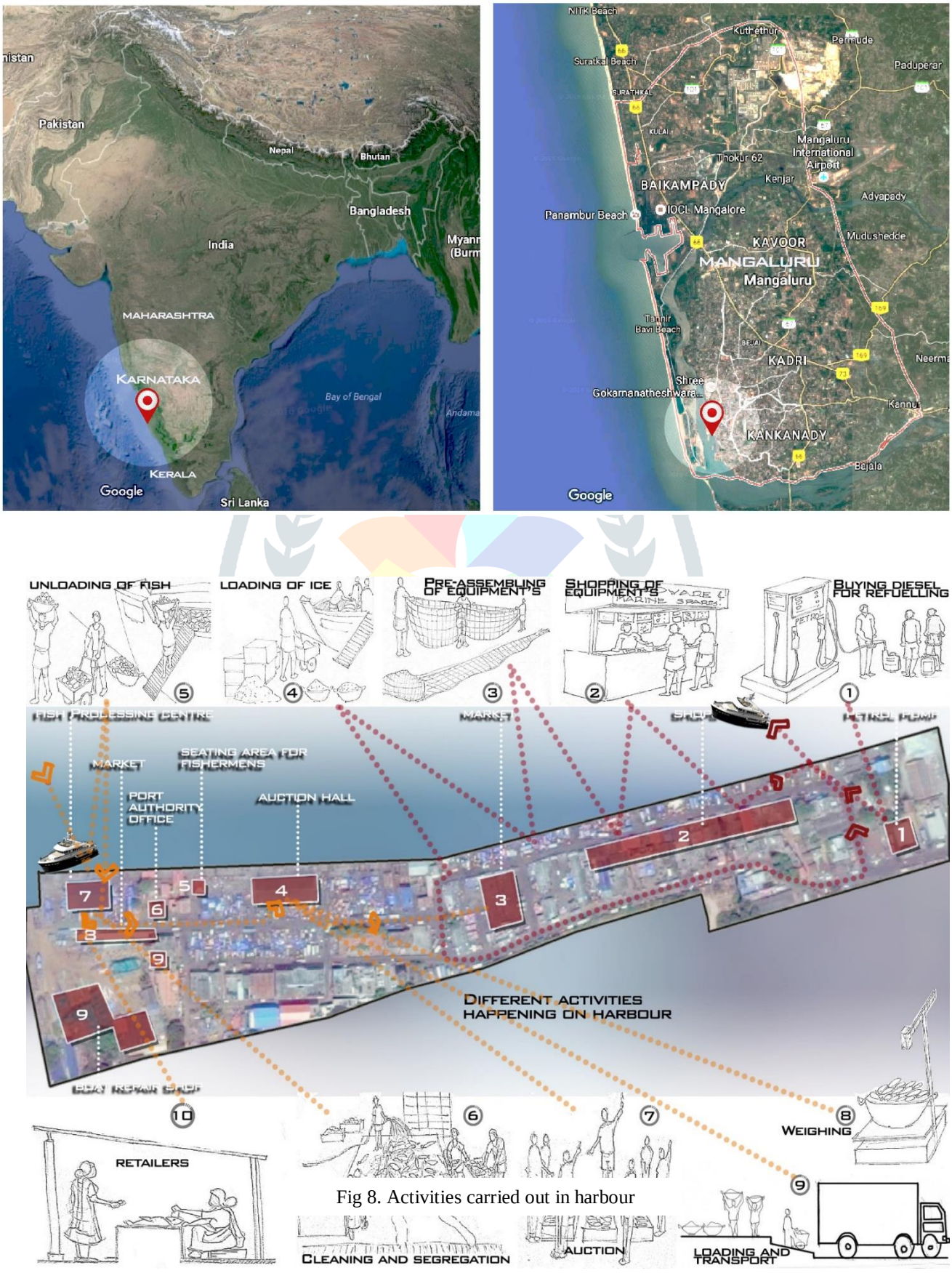



Fig 8. Activities carried out in harbour

**Inferences**

On the harbour most of the activities happens at same time because of that, well planned site circulation is very important. Crowded places like market and auction hall should have the enough distance between them. Movement of crowd is to be taken in

to account. With of the road is sufficient to pass the two trucks at one time. But without any pathways, because of that people walk directly on roads.

Market and auction hall are well over its capacity to handle the goods. Also not having any facility of freezers, storage, or any other machines. Natural ventilation is used, but it is better to use the mechanical ventilation in structures like fish handling and auction hall. Wholesale market is not well planned, fisherwomen carry their own cold storage box to keep the fish. In fish handling center only cleaning, sorting and weighing is done for exporting. All the work is done manually. It is better to use some primary machines and moving belts to improve the quality and speed of work.

**4.1.2. Veraval harbour, Gujarat**

Total area approximately 300,000 sq.m i.e. 74 acres.
Coordinates: 20.91°N 70.37°E

**Observations on existing situation**

Jetty area is surrounded by land from all sides and only small channel is left for entry and exit of boats. Two main landing places are in use, one is on north and one is on south side.

Petrol pump and shops of marine equipment are far away from harbour that's why it is inconvenient for fishermen. For preparation of trip in ocean fishermen repair nets, gather ropes all other required stuffs, no special place is provided for this kind of works. They make temporary shades and do this kind of activities. Sanitation and bathing facilities are not provided close to the harbour. Roads are made up of soil, and in rainy season it is difficult to walk, and transport the fish.

One good thing is provision of rooms for fishermen. They live their when not on trip.

Area where unloading, weighing and export happens is made up of many temporary shelters. In which wholesaler sits and when boat comes on the harbour workers unload all the fish in the boat, next step is weighing and after that fish is exported to big factories for processing and packaging.

For production of new ships and repair of old ships special place is given. Known as naliya godi boat building. It has area around 14 Acers.

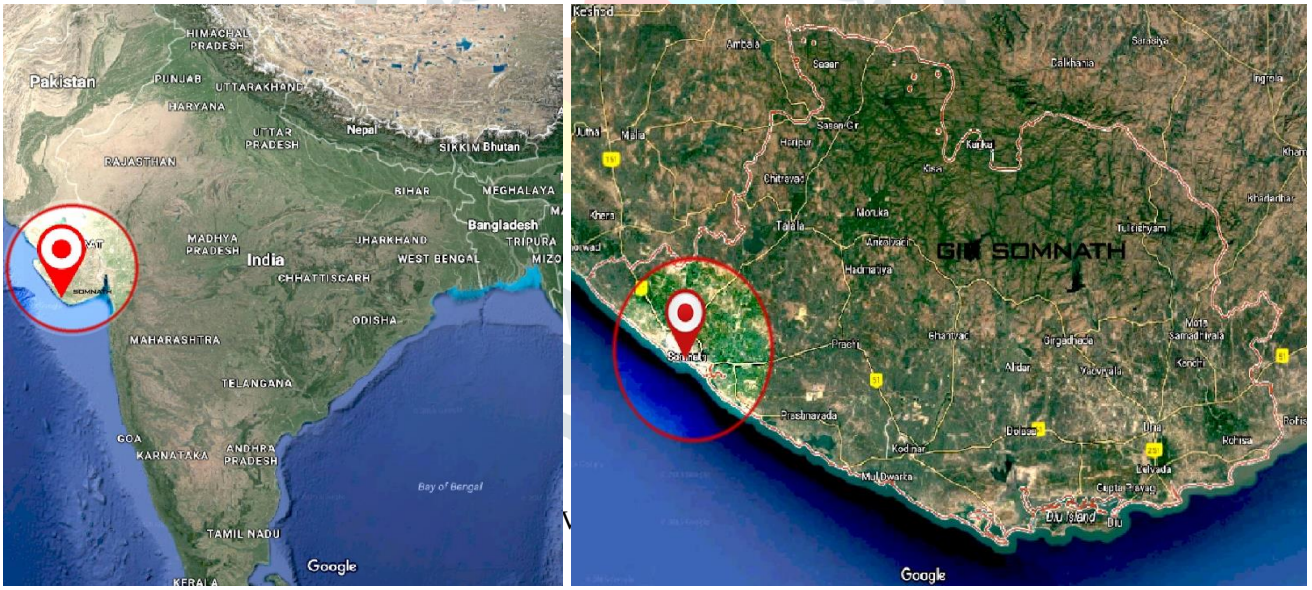



Fig 10. Site Images

**4.2 Secondary study**

Secondary study is derived from the certain government pdfs.

- Consideration of the standards set by major importing countries, particularly the European Union, and the Export Inspection Council of India is paramount when constructing or modernizing a fishing harbour.

- Landing sites and auction centers for fish and fishery products must be situated in areas free from smoke, dust, pollutants, and stagnant water.
- The design and layout of the sites will prevent contamination of the products being handled.
- Adequate covering will be provided to shield fishery products from environmental factors such as sunlight, rain, and wind-blown dust.
- Floors will be appropriately sloped to ensure proper drainage and prevent water stagnation.
- Smooth, raised platforms should be installed for displaying fishery products, facilitating easy cleaning and disinfection.
- Effective drainage systems must be in place for wastewater removal.
- Provision of potable water or clean seawater for cleaning and sanitation purposes is essential.
- Adequate flush lavatories will be available outside the landing sites and auction centres.
- Utensils and equipment used for handling fish and fishery products should be smooth, corrosion-free, easy to clean, and maintained in good condition.
- Loading and unloading practices will avoid unnecessary damage to the edible parts of the products.
- Prominent signboards prohibiting smoking, spitting, eating, and drinking must be displayed.
- Loading and unloading activities will be conducted swiftly to minimize spoilage and contamination of the products.
- Proper icing of fishery products is necessary to prevent temperature abuse, with high-quality ice made from potable water.
- Vehicles emitting exhaust fumes should be prohibited from entering the premises.
- Measures will be implemented to prevent the entry of animals, birds, and insects into the sites.

### 4.3 Tertiary study

Tertiary study is done from the research papers

Selecting the ideal site for a fishing harbour is crucial to ensure water ingress prevention during high tides and uninterrupted boat mooring regardless of tide levels. Breakwaters must be erected to manage wave action, while obstructing constructions impeding water flow are prohibited to prevent water stagnation, ensuring a healthy environment.

A model fishing harbour should include:

- A secured compound wall with a gate to deter stray animals and unauthorized entry.
- Ample parking space for various vehicles, segregated by type.
- Well-designed drainage channels leading to an Effluent Treatment Plant (ETP) for waste management.
- An auction hall equipped with raised platforms and fly-proof netting.
- A well-built wharf and a separate area for net mending.
- Restrooms and bathing facilities for workers.
- Provision of electricity, potable water, and adequate lighting.
- Availability of high-quality crushed ice.
- Permanent waste bins for non-degradable waste disposal.
- Adequate height for easy fish handling in the auction hall, with proper lighting and flooring sloped towards drainage channels.
- Spacious and properly concreted wharf area sloped towards land.
- Net mending hall and restrooms for worker convenience.

## V. Design Considerations

The study concludes that the fishing harbour should be designed in such a way that fishermen community should be benefited socially & economically. The development of the fish harbour will have great cultural & environmental impact.

The design considerations shall be using local materials as far as possible and adding the eye catchy focal point so that the tourist can be attracted to boost economy of the fishermen community as well as to add value & recognition to the place.

The harbour shall be designed with proper space allocation for the marketing purpose. The marketplace will be designed considering the movement of people, a cleaning process, the threat from animals, comfort conditions. Space for repairing nets and preparation space are provided for the trip in the ocean. Space is provided for drying the fish.

The design shall have the kinder garden for the children so they will get good care. Public circulation will be restricted where ever is necessary.

The community hall shall be provided in which educational classes will be held. Training on marketing the fish will be given in this space. Also, this hall will be used for the community festivals, meetings etc.

Fish handling center shall create new jobs for fisherwomen in which they will get a good amount of wedge. Packaging, exporting, and storage facilities will strengthen the fishing sector.

The design shall have the separate dedicated space for fishermen in which they will get a place to stay, eating and drinking place, some shops having fishing equipment's, frozen food for the trip, tea stall, seating space, toilets and bathing facilities, etc.

The location of the site should be close to the tourist places thus enhancing the potential of the harbour to develop as the tourist destinations.

The design shall have the network of pathways which will lead the tourist direct to the jetty from where they will enjoy the beautiful sea view, boats, sunset.

Viewing decks should be designed in as such a manner to give the view of the sea from different levels. Amphitheatre is provided for local dance shows. The restaurant will provide the local food for the tourist. And it will generate jobs for the community.

A home featuring a square, hexagonal, or octagonal floor plan, accompanied by a roof composed of multiple panels (four or more), has demonstrated decreased susceptibility to wind loads.

Roofs characterized by multiple slopes, such as hip roofs (comprising four slopes), exhibit superior performance in withstanding wind forces compared to gable roofs (consisting of two slopes).

Although gable roofs are typically more prevalent due to their cost-effectiveness, a roof slope of 30 degrees yields optimal outcomes in wind resistance.

## VII. Suggestive Remarks

- More technical devices should be introduced in the fisheries industry could enhance fishermen's ability to catch more fish.
- Opening up more markets and processing units for fish marketing could significantly bolster the economy of fishing communities.
- Authorities need to take basic steps to address the pressing issues faced by fisherfolk at sea and along the shorelines. This proactive approach can uplift their morale and improve their quality of life.
- Governmental agencies should thoroughly assess the housing conditions, access to electricity and clean drinking water, and the sanitation situation of fishermen. Remedial measures must be promptly implemented, including simplified procedures for subsidized loans and increased loan and subsidy ceilings.
- Fishing villages often suffer from isolation and inadequate infrastructure, such as roads and transportation. It's crucial for government development schemes to prioritize providing these essential facilities to fishing communities.
- Lack of coordination among various agencies involved in fisheries programs hampers progress. The Fisheries Department should take proactive measures to ensure effective coordination and implementation of these programs.
- Integrating fishermen into mainstream society through awareness programs on savings, education, income generation, and asset creation is essential for improving their standard of living.
- Educating fishermen on prudent spending and saving practices is vital for their financial security and overall well-being. It's crucial to install a culture of saving among fishermen to help them lead more secure lives.

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