ONE OCEAN FOUNDATION

# Ocean Disclousure Initiative

## CONSTRUCTION AND BUILDING MATERIALS INDUSTRY REVIEW

SDA Bocconi SCHOOL OF MANAGEMENT
SUSTAINABILITY LAB

McKinsey & Company

CSIC
Consejo Superior de Investigaciones Científicas

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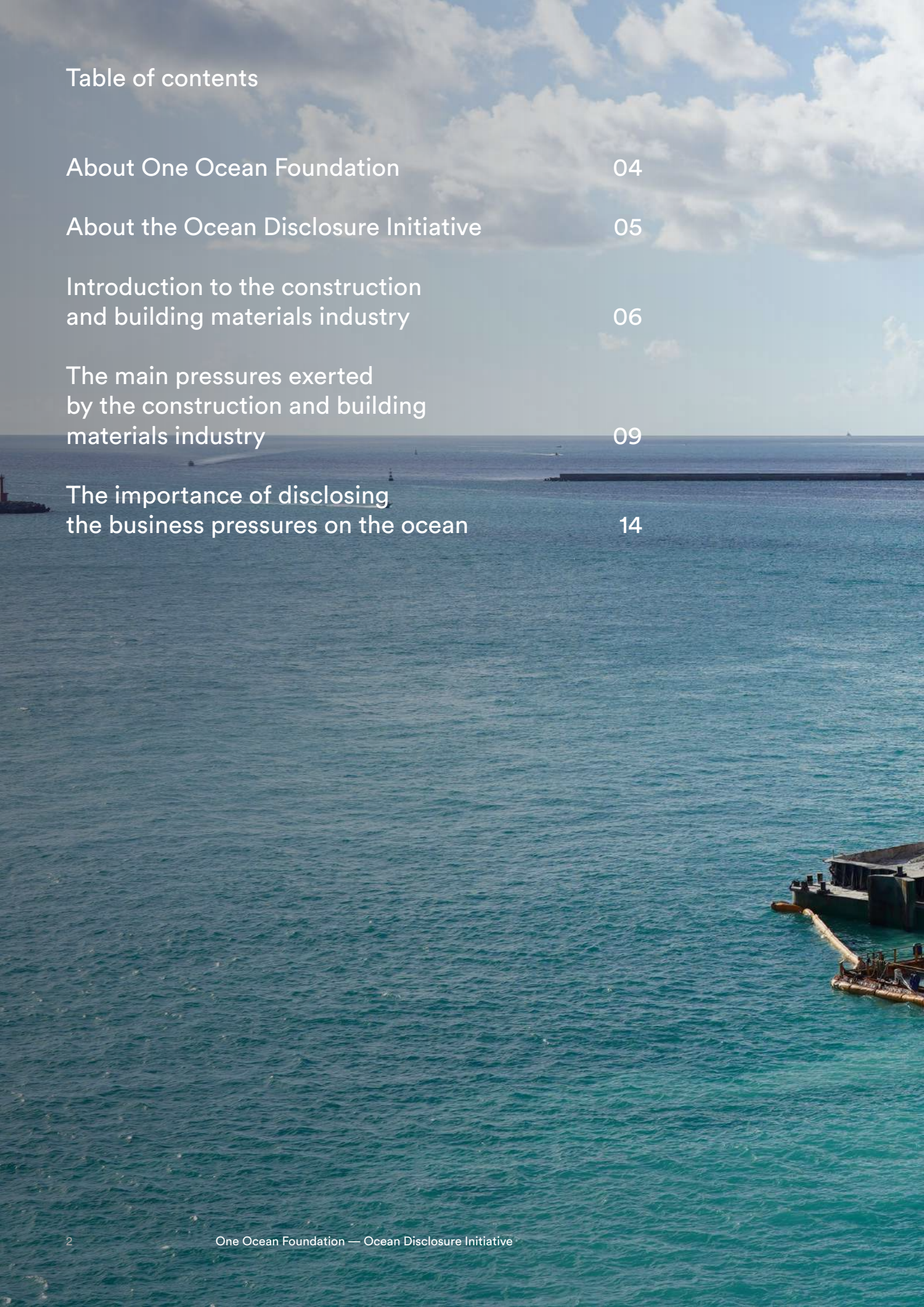

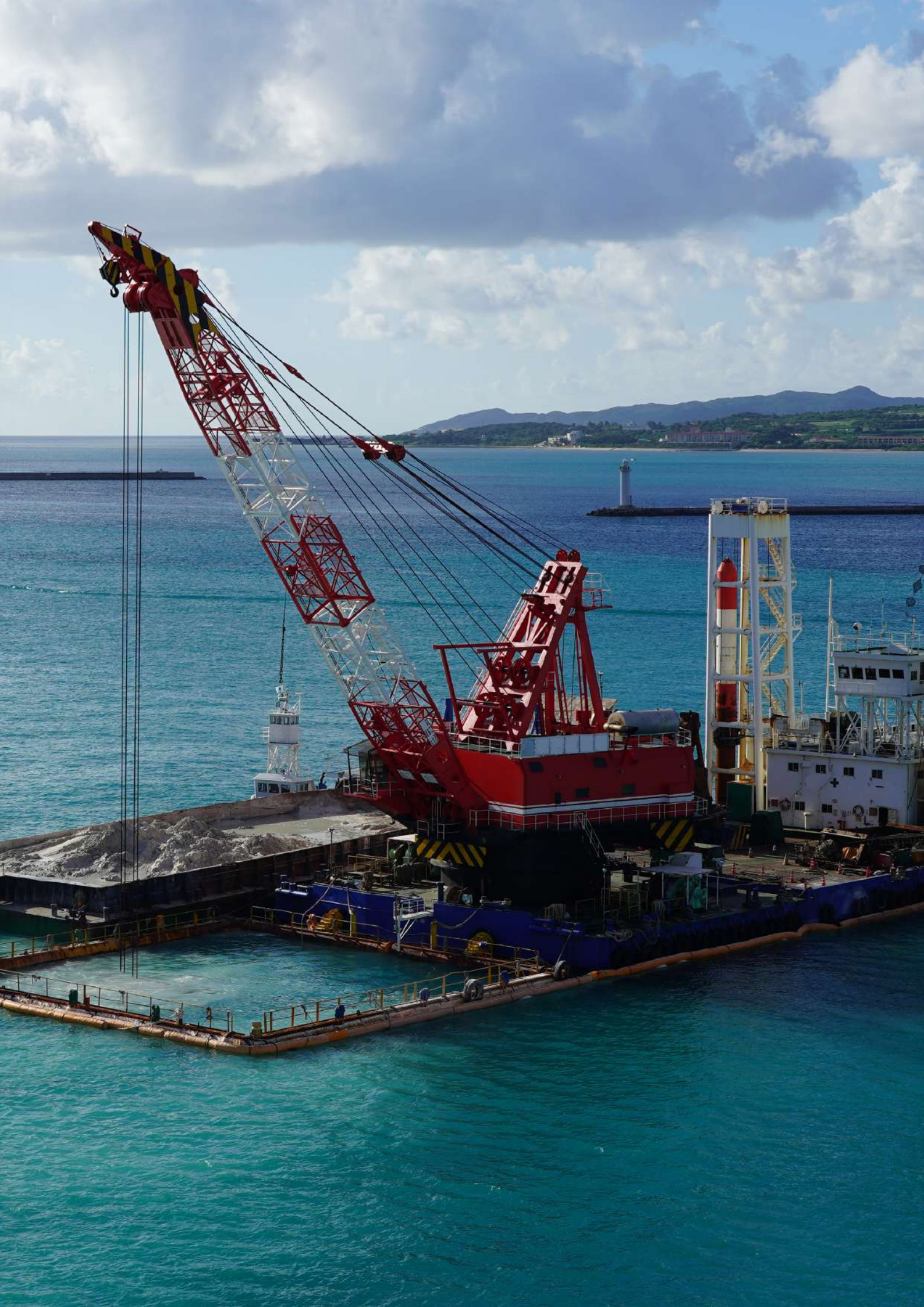

# About One Ocean Foundation

This research is an initiative of the One Ocean Foundation, as part of its project Ocean Disclosure Initiative.

The mission of the Foundation is to accelerate solutions to ocean issues by inspiring international leaders, institutions, companies and people, promoting a blue economy and enhancing ocean knowledge through ocean literacy. The Foundation intends to develop a leading-platform bringing together and strengthening the voices speaking out on behalf of the ocean around the world.

The distinctive feature of the One Ocean Foundation is its scientific scope and, at the same time, its strong educational drive, in order to increase awareness and establish constructive relationships between all stakeholders engaged in marine preservation at different levels.

Thanks to its relevant network of partners, the One Ocean Foundation is engaged in numerous unique, innovative and high added - value projects related to its mission of ocean protection, in three main areas: education, environmental research, blue economy.

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# About the Ocean Disclosure Initiative

The Ocean Disclosure Initiative project is part of the multi-year research "Business for Ocean Sustainability" promoted by the One Ocean Foundation (OOF), in collaboration with SDA Bocconi School of Management Sustainability Lab, McKinsey & Company and CSIC (Consejo Superior de Investigaciones Científicas) and aimed at building knowledge about the relationship between the business and the ocean.

The project started in 2019 with the goal of investigating the role of companies in addressing ocean challenges, focusing on the pressures on marine ecosystems, the level of awareness within the business community and the main (technological and organizational) responses implemented.

The Ocean Disclosure Initiative has the ambition to be a science-based framework and methodology aimed at supporting businesses from all industries in taking action on ocean-related issues, promoting prevention and/or mitigation responses and favouring disclosure and reporting.

# Introduction to the construction and building materials industry

The construction and building materials industry refers to the processes involved in creating buildings, infrastructure, industrial facilities, and associated activities. The process usually starts with planning, financing and designing and continues until the property is built and ready for use. The construction sector also includes repair and maintenance works, any operations to expand, extend and improve the asset, and eventual demolition, dismantling, or decommissioning.

Overall, the construction industry and building materials industry is one of the most important to the global economy in terms of its value and its contribution to economic growth, quality of life, and the creation of jobs worldwide, and it is closely connected to other industries. Nevertheless, it is also one of the most resource and energy-intensive sectors of the economy and one of the biggest waste-generating industries. For this reason, it has been analysed in the framework of the Ocean Disclosure Initiative (ODI), by reviewing relevant material and sectoral publications on the environmental pressures of the industry, along with sustainability reports from the main stakeholders in the sector. The core objective of the analysis is to map and better understand the pressures exerted on marine ecosystems thus creating the basis for the industry-specific edition of the ODI tool dedicated to construction and building materials industry. To this end, the following paragraphs introduce the industry and present its main pressures on the ocean.

**THE CONSTRUCTION AND BUILDING MATERIALS INDUSTRY IS ONE OF THE MOST RESOURCE AND ENERGY-INTENSIVE SECTORS, ACCOUNTING FOR 37% OF ENERGY - AND PROCESS - RELATED $CO_2$ EMISSIONS AND OVER 34% OF ENERGY DEMAND GLOBALLY.**

Recent literature highlights that in 2021, the construction and building sector accounted for around 37% of energy- and process-related $CO_2$ emissions and over 34% of energy demand globally, representing an increase of around 4% from 2020, the largest increase in the last 10 years[1]. Moreover, $CO_2$ emissions from building operations[2] have reached an all-time high of around 10 $GtCO_2$, representing a 5% increase from 2020[3].

Construction can occur on land, near the coast and in the ocean. Piers, bridges, tunnels, offshore platforms (usually for the production and transfer of electricity, oil, and gas), ports and marinas, aquaculture infrastructure and artificial reefs are examples of construction in the ocean itself. Scientists have found that an area of approximately 30,000 square kilometres – the equivalent of 0.008% of the ocean – has been modified by human construction, and this area is expected to increase in years to come[4].

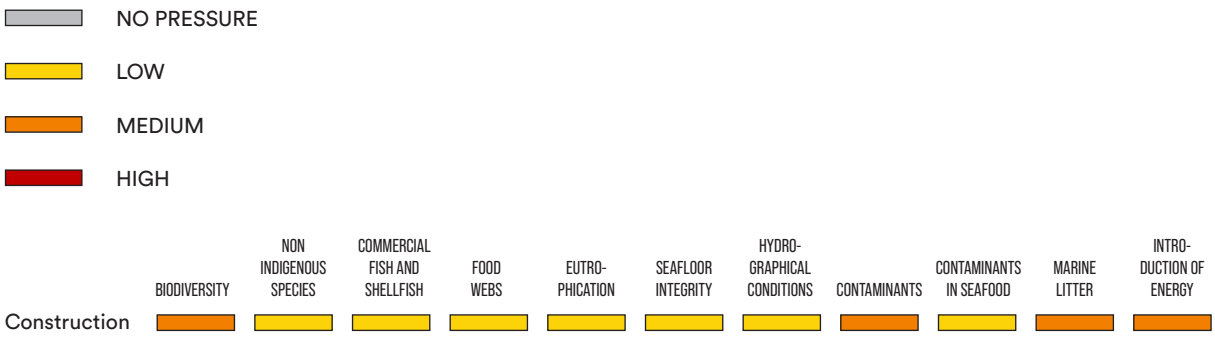
Each construction phase can exert significant pressures on the marine environment, with direct pressures mainly associated with offshore and nearshore construction and indirect pressures mainly associated with inland construction. In particular, building materials, from their extraction to processing and transportation, represent a fundamental aspect of the sustainability of the construction industry as a whole, considering that urbanisation and population growth have contributed to a tripling of demand and consumption between 2000 and 2017[5].

1. United Nations Environment Programme (2022). 2022 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. Nairobi.
2. In the building sector, the aspects linked to the reduction of GHG emissions are negotiated with the clients in the design phase.
3. Ibidem
4. Bugnot, A. B., Mayer-Pinto, M., Airoldi, L., Heery, E. C., Johnston, E. L., Critchley, L. P., ... & Dafforn, K. A. (2021). Current and projected global extent of marine built structures. Nature Sustainability, 4(1), 33-41.
5. Huang, B., Gao, X., Xu, X., Song, J., Geng, Y., Sarkis, J., ... & Nakatani, J. (2020). A life cycle thinking framework to mitigate the environmental impact of building materials. One Earth, 3(5), 564-573.

Evidently, different building materials generate different levels of emissions. For example, it is recognised that manufacturing cement, steel and concrete carries the most severe environmental burden in terms of industrial carbon dioxide emissions[6]. The steel and cement industries have been registering significant progress in the reduction of emissions, but the path to sustainability remains long and complex. The production of materials like clay, meanwhile, which is based on the mixing of clay and water, requires fewer energy inputs and emits less $CO_2$ per tonne when compared to steel, concrete, and aluminium. As the scientific review has revealed, the most significant pressures exerted by the construction industry affect the following aspects:

— Loss or reduction of biodiversity
— Marine water contamination
— Introduction of marine litter
— Introduction of energy in terms of light, noise, and vibration

FIGURE 1: Review of the negative pressures of the construction and building materials industry*




Source: Ocean Disclosure Initiative, One Ocean Foundation, 2021

* Pressures exerted on the eleven Good Environmental Status descriptors (GES) of EU marine waters, listed in the figure as identified in the Marine Strategy Framework Directive of the European Union. https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

6. Roh, S., Tae, S., Suk, S. J., & Ford, G. (2017). Evaluating the embodied environmental impacts of major building tasks and materials of apartment buildings in Korea. Renewable and Sustainable Energy Reviews, 73, 135-144.

# The main pressures exerted by the construction and building materials industry

Core activities of the construction sector cause these environmental pressures and have far-reaching consequences on marine ecosystems:

## 1. GHG emissions and air pollution

THE CONSTRUCTION SECTOR IS RESPONSIBLE FOR ALMOST ONE-THIRD OF THE WORLD'S TOTAL ENERGY CONSUMPTION AND NEARLY 15% OF DIRECT $CO_2$ EMISSIONS, THUS CONTRIBUTING TO GLOBAL WARMING, OCEAN ACIDIFICATION AND DEOXYGENATION.

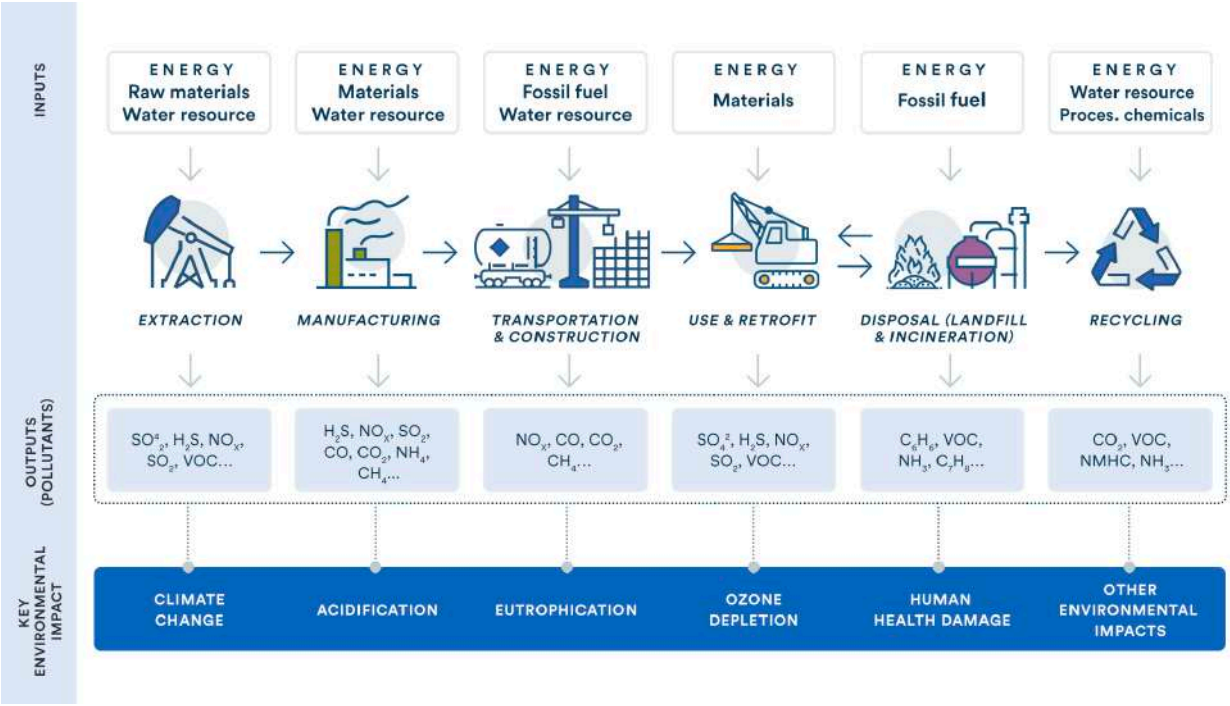
The construction industry utilises large quantities of fossil fuels both in the manufacturing of building materials (primarily cement, concrete, and steel) and as a source of energy. According to the International Energy Agency, the sector is responsible for almost one-third of the world's total (final) energy consumption and nearly 15% of direct $CO_2$ emissions[7]. Construction activities, including among others asphalt works, land clearing, excavation, movements of vehicles, and demolition, can also generate a high amount of dust (re-suspended dust particles), bituminous aerosol, and smoke, resulting in increased air pollution and high amounts of atmospheric $CO_2$.

Global warming due to GHG emissions potentially affects water temperature, as the ocean absorbs excess heat from the atmosphere. This exerts negative pressures on marine species and ecosystems as rising water temperature leads to deoxygenation, which results in a high level of mortality, loss of breeding grounds and mass migration. The increase in carbon dioxide concentration is also responsible for progressive ocean acidification, with detrimental effects on marine habitats, species and food webs. Moreover, heavy machinery and equipment use contributes to nitrogen oxide (NOx) emissions, chemical compounds of oxygen and nitrogen formed during fuel and organic material combustion at high temperatures. The load of nutrients, including NOx, represents the main cause of eutrophication, a phenomenon that entails the proliferation of aquatic plants and micro-organisms that consume oxygen at the expense of other marine species, affecting biodiversity.

7. International Energy Agency IEA (2022). Buildings. A source of enormous untapped efficiency potential https://www.iea.org/topics/buildings

As already mentioned above, different building materials generate different levels of emissions. Specifically, research has proved that rammed earth is the raw material with the lowest rate of greenhouse gas emissions/kg, while flat glass is the material with the highest rate[8]. Furthermore, the different phases of the construction industry, from the extraction of raw materials to the disposal of the asset and recycling of the released materials entail the emission of various air pollutants that exert a range of pressures on the environment and specifically on the ocean, as shown in the following diagram.

FIGURE 2: Review of the sources of pollution in the sector divided by phase




Source: Author's elaboration

8. The Effect of building materials on the environment. https://dontwastemy.energy/2021/01/26/the-effect-of-building-materials-on-the-environment/

Best practices. To reduce GHG emissions in the industry, best practices include i) enhancing the efficiency of existing construction machinery; ii) the use of innovative technology, such as new electric melting ovens and electrification in general wherever possible; ii) the use of cleaner energy, for example converting production from coal to natural gas or novel sources such as hydrogenated vegetable oil (HVO), green or blue hydrogen, and iii) the introduction of more efficient energy management systems that include advanced energy analyses, monitoring, benchmarking, and control of energy peaks with the aim of reducing energy consumption.

## 2. Contaminants and water pollution

Pollutants from the construction industry can contribute to water contamination by entering water systems through runoffs, drainage systems, accidental spills, and leakage into soil. Contaminants from construction activities include essentially chemicals, such as solvents, paints, synthetic resins, waxes, fuels, adhesives, and heavy metals (zinc, aluminium, chromium, etc.) that may display different levels of toxicity. These substances can enter rivers or streams through stormwater and wastewater discharge, eventually reaching the ocean and contributing to changes in the chemical composition of seawater and water quality. In particular, nitrogen and phosphorous used during construction works can contribute to the eutrophication mentioned previously; the production of steel, for example, emits large amounts of nitrogen oxides – while this element is crucial to life and naturally found in soil, plants, water, and air, excessive concentrations can affect biodiversity and aquatic environments.

CHEMICALS AND HEAVY METALS USED IN CONSTRUCTION ACTIVITIES CAN ENTER RIVERS OR STREAMS THROUGH STORMWATER AND WASTEWATER DISCHARGE, EVENTUALLY REACHING THE OCEAN AND CONTRIBUTING TO CHANGES IN THE CHEMICAL COMPOSITION OF SEAWATER AND WATER QUALITY.

Best practices. To reduce or avoid contamination of water bodies, best practices include the implementation of management measures and plans (e.g. spill prevention and response plan) that set out regulations on appropriate handling and storage of harmful substances and chemicals and the use of biodegradable oils wherever possible. Moreover, water control systems to prevent water leakages, together with the installation of more water-efficient equipment and waterproofed areas, ensure the limitation of discharge of wastewater into the environment.

### 3. Waste and marine litter

Excavated material, solid and sanitary waste generated from construction activities that might be deposited in landfill sites, has the potential to pollute the soil through leachates and reach aquatic environments. Moreover, these residues can enter the ocean directly in case of poor management or accidents from coastal and offshore construction and indirectly through freshwater intake from inland construction. Among these materials are bricks, concrete, plasterboard, waste asphalt, rocks and general plastic litter, paper and insulation foam, but also organic matter used in certain building technologies such as wood, straw, bamboo, cellulose insulation, sand, clay, soil, natural paints, and oils or waxes.

WASTE FROM CONSTRUCTION INDUSTRY CAN ENTER THE OCEAN AND POLLUTE THE MARINE ENVIRONMENT BOTH THROUGH LEACHATES IN LANDFILL SITES, POOR MANAGEMENT AND ACCIDENTS FROM COASTAL AND OFFSHORE AND FRESHWATER INTAKE FROM ONSHORE ACTIVITIES.

Best practices. To reduce and implement more sustainable ways of treating waste, best practices include the implementation of effective collection systems to reclaim material, as well as the waste management hierarchy consisting of minimisation, reuse, recycling, and disposal. Moreover, regular equipment maintenance and machinery inspections need to be performed. Industrial waste, either solid or liquid (e.g. excavated material, solid waste, sanitary waste, etc.), must be managed according to appropriate national regulations and industry best practices; for instance, transportation, storage, and disposal of hazardous materials in selected storage areas isolated from the surrounding environment with the use of curbs, with spill trays used under storage bulks.

## 4. Use of marine sand

The construction industry is characterised by the extensive use of sand as a component in building materials (e.g. concrete), for basement backfilling, and to build artificial islands or replenish coastlines. This is basically because the construction industry considers the rounded grains found in ocean sand more suitable for concrete production compared to the angular grains taken from the desert[9].

THE DREDGING AND EXTRACTION OF SAND FROM THE SEAFLOOR USED FOR SELECTED CONSTRUCTION PROCESSES CAN LEAD TO THE DEGRADATION OF SEABED MORPHOLOGY, ULTIMATELY AFFECTING MARINE HABITATS AND BIODIVERSITY, REDUCING FAUNAL ABUNDANCE, AND SHIFTING SPECIES COMPOSITION.

Dredging and extraction of sand from the seafloor lead to seabed degradation and loss of biodiversity since these activities contribute to destroying marine organisms, habitats and ecosystems, with a net decline in faunal abundance and a shift in species composition[10]. In coastal areas, direct removal of sand can contribute to coastal degradation with consequent detrimental effects on dune systems. Moreover, both the withdrawal and the incorrect disposal of such sand, including its re-introduction into the marine environment as waste, can lead to the alteration of the hydrological characteristics of the marine environment (change in water flows, flood regulation and marine currents) and to increased water pollution.

Best practices. To reduce the consumption of sand, best practices can include the use of alternative sources, for example, aggregates that accumulate at the bottoms of dams, quarry dust, wood, straw, and recycled material. To avoid possible contamination, sand and other aggregates should be handled and stored carefully, following specific regulations.

Finally, the construction industry can contribute to pollution from light, noise, and vibration, meaning the introduction of energy into the environment that has the potential to affect biodiversity and disturb fauna in the surrounding construction areas – inland, nearshore, and offshore.

9. Sand, gravel and phosphate from the sea, World Ocean Review. https://worldoceanreview.com/en/wor-3/mineral-resources/deposits-and-markets/sand-gravel-and-phosphate-from-the-sea/
10. UNEP Global Environment Alert Service (GEAS) 2014

# The importance of disclosing the business pressures on the ocean

The industry-specific edition of the Ocean Disclosure Initiative tool dedicated to the construction and building materials sector, developed by One Ocean Foundation in collaboration with its partners, reflects the main pressures exerted by this sector with the aim to support companies in becoming aware of their impacts on marine ecosystems, assessing the related risks, and disclosing key information and strategic responses on the significant issues related to construction activities. As identified in our research and reflected in the industry-specific tool, these pressures include i) the introduction of chemical pollutants and litter into the marine environment, ii) GHG emissions from sector's operations iii) the withdrawal and consumption of water, iv) the contribution to eutrophication for cement production and v) the extensive use of marine sand.

The importance of the Ocean Disclosure Initiative is related to the fact that, for the first time, companies, scientific and financial communities, and civil society can rely on a common language to measure, address, and mitigate the most relevant pressures that humanity exerts on the marine environment, sector by sector, with significant advantages for the health of the ocean.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