Policy Document

Climate-Responsive Construction

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Photo: Schwarzbach/MISEREOR

1. Introduction

“It is not enough to seek the beauty of design. More precious still is the service we offer to another kind of beauty: people’s quality of life, their adaptation to the environment, encounter and mutual assistance.” **(LS 150)**

The world population is growing. More and more people need housing and infrastructure for a good life. New settlements and rappidly growing cities further increase this need. At present about 3.5 billion people live in cities. The United Nations predicts that by 2050 this figure will rise to about six billion. The informal settlements that currently house almost one billion people could thus acquire an additional one to two billion inhabitants. Cities in Asia and Africa are expected to experience the biggest increase.[1]

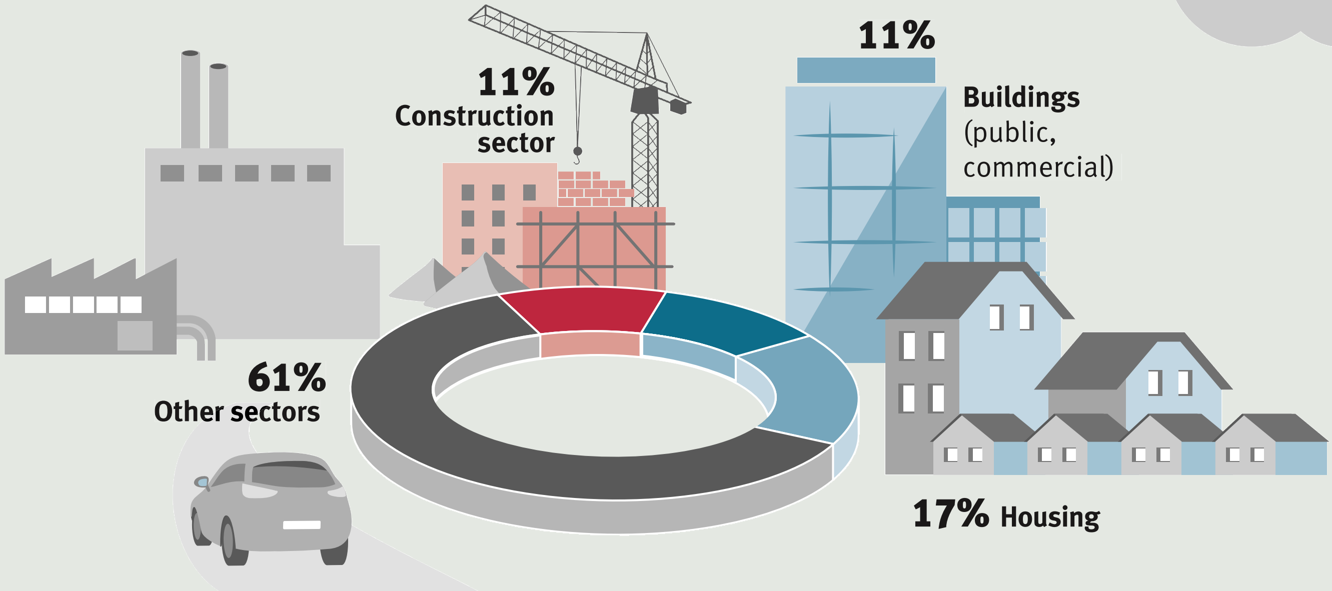
To house these people, it is often necessary to build. MISEREOR and many of its partner organisations agree that not only social and economic criteria but also environmental ones should be taken into account in the building process. We regard a responsible approach to all construction-related decisions as contributing to the achievement of the objectives of the 2030 Agenda and the Paris Climate Agreement. Climate change is already having devastating impacts: we are seeing an increase in extreme weather events such as unusually long periods of heat and drought or heavy rainfall. Rivers burst their banks; floods are becoming more frequent. In coastal areas the steady rise in sea level is putting houses, social facilities and vital supply structures at risk.

In the Paris Climate Agreement the international community agreed to prevent the average global temperature rising by more than 1.5 °C by comparison with pre-industrial levels. We are currently heading for global warming of at least 3 °C. Construction plays a significant part in this: the construction industry is responsible for 11% of global energy-related CO_2 emissions and buildings and the construction sector together account for 39%.[2] This means that additional infrastructure and the new housing that is needed can no longer be built with the conventional materials such as steel, cement and aluminium that the industrialised countries of Europe and North America have traditionally used. Just the expected infrastructure expansion in developing and emerging countries would use up about three-quarters of the CO_2 budget (350 gigatonnes of CO_2 emissions) that must be adhered to if global warming is to be kept within the 1.5 °C limit.[3]

The buildings and construction sector plays a key part in implementation of the Paris Climate Agreement and global sustainability targets (2030 Agenda). Environmental aspects are just as important as the social obligation to create the infrastructure that enables people to live in dignity. These environmental aspects include not only protection of the environment and steps to mitigate climate change but also the need to adapt construction projects to changes in climatic conditions – with regard to both the production and use of building materials and to the energy balance of buildings. The construction of new infrastructure and new buildings should go hand-in-hand with

1 UN DESA 2018
2 The energy consumption of buildings covers emissions from room heating, cooking, water heating, household appliances, lighting and room cooling. UNEP 2018
3 Müller et al. 2013

Buildings and the construction sector are responsible for 39% of global energy-related emissions.



Figures: 2017; Source: Global Status Report 2018, IEA; Ill.: Infotext, Berlin

Note: The emissions of the construction section include the estimated emissions of the industry responsible for producing the materials – such as steel, cement and glass – used in building construction. Emissions arising from the transport of construction materials are not included. The "Buildings" category comprises both direct and indirect emissions arising from the use of buildings.

phasing out the use of fossil fuels in electricity generation, in the transport sector, and in the provision of heating and cooling. Urban planning and land-use planning should aim to avoid and reduce the use of fossil fuels, for example by building more compact developments and preventing commuting. In addition, buildings and infrastructure must be designed to be as resilient as possible to the growing impacts of climate change, which in some regions will involve heavy rainfall and in others extended periods of heat.

Housing construction projects on the basis of communal self-help and the construction of healthcare, educational and social facilities have always been an important aspect of the work of MISEREOR and its partner organisations. This position paper draws on the extensive experience of MISEREOR and its partner organisations to formulate principles for the promotion of projects in the construction sector. These principles are designed to serve as guidelines for project work and also to encourage productive dialogue with decision-makers in the political arena and the construction industry.

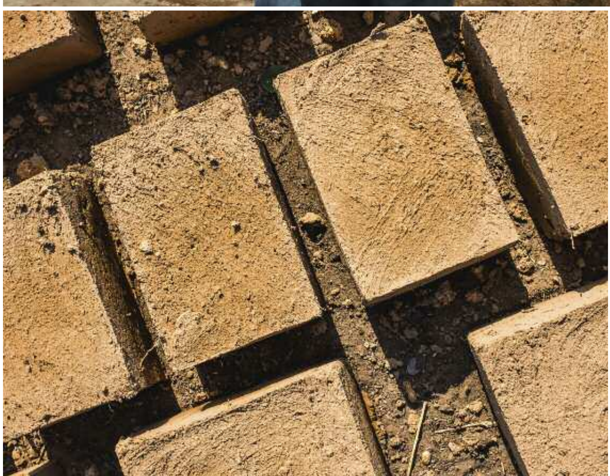
Photo: Schwarzbach/MISEREOR

2. MISEREOR's basic principles for climate-responsive construction

The main target group of the construction projects supported by MISEREOR is people living in very simple conditions in informal, self-organised urban settlements, on waste land beside railway tracks, in run-down inner-city buildings or crudely constructed shacks in rural areas. Building projects funded by MISEREOR also support people made homeless by natural disasters such as earthquakes. Construction projects should create a basis for dignified living and the development of a peaceful social environment. They therefore also include the construction of basic infrastructure, training facilities, health centres and social facilities.

All construction projects funded by MISEREOR must meet certain quality criteria. They must comply with building and fire protection regulations. In design and construction, consideration must be given to context-

Congo: Production of pressed clay bricks for house buildings



Photos: Alexandre Douline (top), Soteras/MISEREOR (bottom)

Photo: JM-PPK

Cement production in Indonesia

The karstic rock formations of the Kendeng Mountains are rich in limestone, gypsum and rock salt, making them attractive to the cement industry. The Indonesian company Indocement, a subsidiary of the German HeidelbergCement AG, is planning to construct another cement works in the region. Karst landscapes are classed as protected areas in Indonesia. The karst acts as a rainwater reservoir and is part of a water catchment system that is important to local farmers. The planned operations will have devastating impacts on humans and nature, but the government has granted Indocement environmental approval for the mining. Members of grassroots campaigns such as JMPPK are protesting by cementing their feet and are going to court in an attempt to halt the planned assault on the environment – thus also calling for an end to the worldwide cement boom.

"We don't need a cement factory here! This factory destroys not only our livelihoods but also our social relationships,"
says Gunarti, a member of the indigenous Samin community and a representative of the local JMPPK campaign group.

specific and climatic conditions, environmental and climate change mitigation requirements, social and economic fairness and cultural aspects. To ensure that natural habitats are preserved for future generations, construction activities and the manufacture of building materials must not impact adversely on ecosystems and the environment.

The worldwide increase in the use of cement and aggregates (sand, gravel) and in the use of steel and aluminium for construction purposes is having serious consequences for the climate and environment. A return to local building methods and environmentally sound or renewable building materials would at least alleviate the pressure on natural resources and ecosystems.

For some time MISEREOR and its partners have therefore been promoting construction with local materials (earth, wood, bamboo, stone) as an adapted, low-cost, energy-saving and climate-responsive alternative to buildings of concrete or burnt brick. It has done this mainly in Africa and Latin America, and occasionally also in Asia.

Adaptation to social and cultural conditions is another important aspect of sustainable construction and the subsequent maintenance of buildings. Building projects can usefully draw on local knowledge, support people in local manual trades, foster a sense of initiative among local people and mobilise traditional forms of solidarity-based self-help within a neighbourhood or community.

3. Energy-saving as a key component of climate-responsive construction

Because it consumes energy, resources and land, building always involves intervening in an existing ecosystem. The task of MISEREOR and its partner organisations is to minimise these interventions. The first step involves drawing up plans that ensure that construction is appropriate, suitable for its purpose, and does not require excessive consumption of land and resources. Secondly, the choice of location is a crucial aspect of climate-

Honduras: Clay construction (adobe and bahareque) and the design of the training centre with adequate ventilation provide a good interior climate without the need for air conditioning

Photos: Schwarzbach/MISEREOR (top), Javier Rodriguez (bottom)

Haiti: Building a house using local, earthquake-resistant timber-framed methods. Natural stone, clay wattling or clay bricks are used for infilling, depending on what materials are available locally.

responsive and energy-saving construction. Thirdly, climate-responsive design ensures that construction and use of the building requires as little energy as possible. In regions with strong solar insolation and high temperatures, buildings have to be designed in ways that avoid the use of electric air-conditioning or keep it to a minimum. In colder regions, heating energy should be saved by using the heat input of solar insolation.

Climate-responsive construction takes account of the entire supply chain and the complete life cycle of the building. In most types of construction, the majority of the energy consumption and CO_2 emissions associated with the building process are attributable to the production and transport of materials. Industrially produced building materials should therefore be avoided wherever possible. Demolition of a building constructed of local materials results in only a small quantity of material that is costly to dispose of. This saves energy, cuts costs and reduces greenhouse gas emissions. Traditional building methods using locally available or recycled materials should therefore be promoted preferentially.

There are many ways to save energy during the useful life of a building. Appropriate building materials (such as clay and earth) create a comfortable indoor climate and avoid or reduce the need for artificial air-conditioning. Thermal optimisation of the building (insulation) saves energy during the usage phase; the use of renewable resources for electricity generation, heating and hot water supply reduces consumption of fossil fuels. During the building usage phase, users are chiefly responsible for saving energy. Regardless of whether the building is a house, a school or a clinic, educating people about energy-saving and raising public awareness is a fundamental element of climate-responsive construction.

4. Choosing the building materials

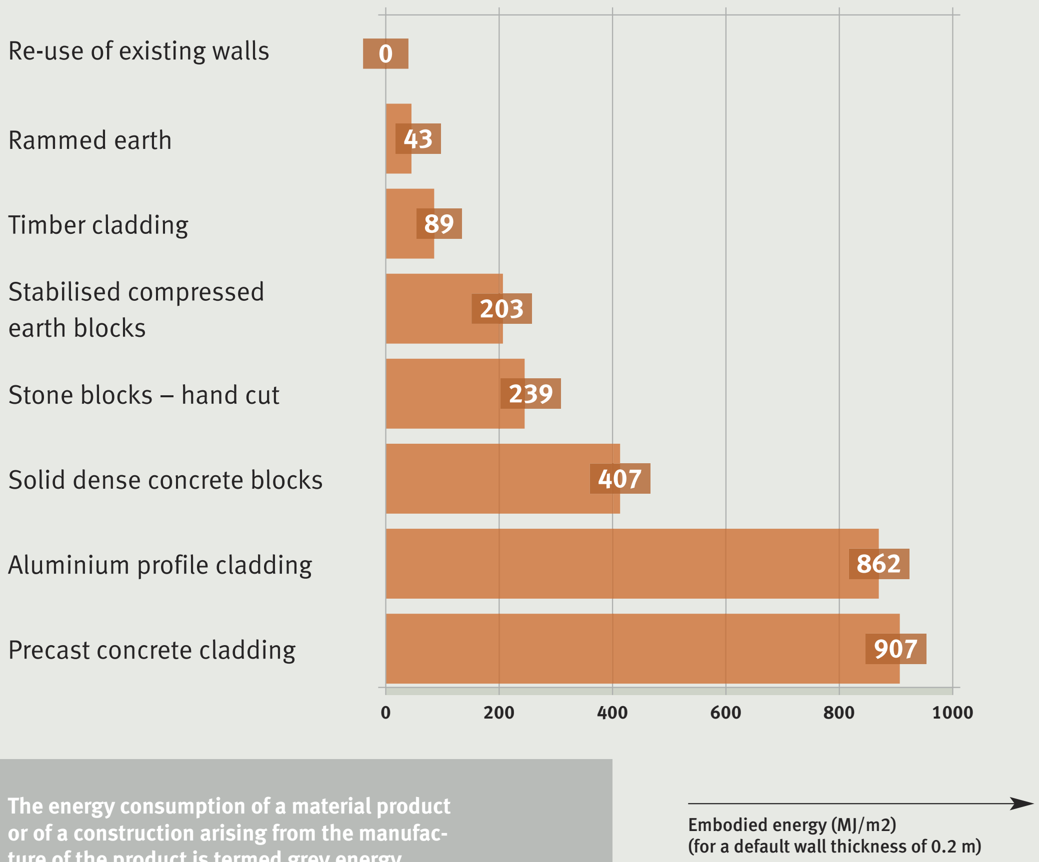
The careful choice of building materials is another key issue in all construction projects. Aspects to be considered include not only the physical properties of particular materials and their local availability but also local climatic, seismic and cultural requirements. In eco-friendly and climate-responsive construction, the choice of materials will be based on careful consideration of the energy consumption and CO_2 emissions of the construction project; the aim must be to avoid environmental impacts or keep them to a minimum.

Locally available building materials that are not industrially manufactured are likely to have advantages in terms of quality and of impact on the climate and environment. A welcome side effect is the fact that local materials often significantly reduce construction costs.

Manufacturing steel, cement (as the basis of concrete and reinforced concrete) and aluminium is extremely energy-intensive. Building projects should attempt to avoid the use of industrially produced ma-

Photos: Kopp/MISEREOR

Energy balance of wall construction materials



Source: International Finance Corporation 2018

The energy consumption of a material product or of a construction arising from the manufacture of the product is termed grey energy. It includes transport from the source of the materials to the end product and thus covers energy consumption in the course of resource extraction, preparation and processing, transport and manufacture of the construction products. To reduce energy consumption to a minimum, existing walls should be re-used wherever possible. Industrially produced materials such as concrete and aluminium are far more energy-intensive than locally available construction materials such as clay or wood.

terials such as cement, concrete, steel and aluminium that have dominated the construction industry for decades. However, it is often not possible to do without these materials altogether. It may be necessary to use cement, concrete or structural steel, for example because:

- local, non-industrially produced materials are unavailable,
- they are needed to make buildings earthquake-proof,
- loads need to be carried across wide spans and it is not possible to shorten the span or use different materials,
- no other suitable materials for the construction of foundations, floor slabs etc. are available

Burnt bricks: to be recommended only with reservations

Burnt bricks are widely used as a building material all over the world and they have the advantage of being easy to work with. However, burning bricks uses a great deal of energy. This energy usually comes from fossil fuels or from wood fires, putting forests and trees in the vicinity of cities at risk. Industrially manufactured bricks can be used to construct multi-storey buildings. However, they should not be used as a building material unless they are produced in environmentally friendly and energy-saving ways or unless use is made of recycled burnt bricks from demolished buildings

Local building materials

MISEREOR classes materials such as clay, wood, bamboo and natural stone as local building materials.

Photos: Soteras/MISEREOR (left), Adelheid Wehmöller (right)

Congo: The training centre is of clay construction (compressed clay bricks). The material was obtained on-site.

Haiti: The school was built using a mixture of wood and clay (timber frame with clay brick infill). The building is designed to be earthquake-resistant.

Where they occur they are usually plentiful and need to be transported only short distances. This gives them a major advantage. In addition, obtaining and using them usually requires very little energy. Local materials are also associated with traditional building methods and local architectural styles; using them can help revive these traditions, involve the local population and enable them to identify with the buildings. Using these materials is usually labour-intensive; this creates jobs locally. Demolition does not involve costly disposal of building materials, and materials can often be re-used. All this saves energy and costs and reduces greenhouse gas emissions. To ensure the sustainability of local building materials, overuse of resources must always be avoided and conservation of ecosystems and the environment must be a priority.

Building with earth and clay

In the first instance, building with earth needs nothing more than a supply of clayey soil – something that is given at many locations. The clay is often dug up on the building site or from a nearby clay pit and then mixed with sand. It is important to get the proportions right: if it is too sandy it will be crumbly, and if it contains too much clay the brick will tend to crack. In hot parts of the world clay brick buildings are pleasantly cool inside; at cold times of the year the walls retain heat and regulate humidity, creating a comfortable interior climate with pleasant humidity. Dried clay preserves wood; it can thus be combined without difficulty with structural elements of wood or bamboo.

There are three different types of earthen construction: clay brick (adobe), rammed earth (pisé) and classical wattle and daub (bahareque, quincha) in which a wooden lattice is covered with loam. Clay bricks enable arches to be constructed. Rammed earth methods involve encasing earth in wooden formwork and compressing it to form solid walls.

Clay buildings need to be protected from wet conditions by means of roof overhangs and drainage ditches. Atmospheric humidity, on the other hand, is not harmful. In dry parts of the world there are impressively tall buildings of rammed earth or clay bricks that

Photos: Adelheid Wehmöller (left), Kopp/MISEREROR (right)

Haiti: This house built on the self-help principle is of earthquake-resistant traditional construction involving timber framing with natural stone infilling.

Myanmar: The centre's open and airy multi-purpose hall, which is 25 metres long and about six metres high, is built entirely of bamboo and roofed with bamboo shingles.

have survived for centuries. However, it is in general rarely possible to build multi-storey build-ings of clay. Clay construction is therefore most suitable for rural and suburban housing, schools, social facilities, etc. If the earth needs to be brought in from a distance – for example, in areas with sandy or stony soils – other construction methods should be considered.

Building with wood

Wood is classed as a renewable building material. Relatively little energy is required to produce it, and because it is a carbon sink, wood is particularly eco-friendly. It has excellent static and physical properties. Being pliable and interactive, it performs very well in traditional frame wall construction and modern timber-framed structures. These characteristics also make it highly resilient to tremors and earthquakes. In addition, wood provides thermal insulation and is both visually and haptically very pleasant. Once the timber has been felled it must first be adequately seasoned. In addition, wood needs to be protected against pests, especially termites. Biocide-free wood preservatives or mechanical barriers are recommended.

Objections to the use of wood on the grounds that it is a flammable and allegedly non-solid building material are now regarded as outdated. Wooden houses provide a pleasant interior climate and good earthquake resistance. With adequate sizing and environmentally friendly treatment methods, wood is now so fire-resistant that building regulations (e.g. in Germany) even permit the construction of multi-storey wooden buildings in city centres. Wood is also ideal for ceilings, roof structures, door frames, window parapets, lintels and ring beams, for example in clay or brick buildings.

For wood to be classed as a sustainable building material, it must come from sustainable forestry (as a minimum with the FSC seal). This means that not only must wood be available locally but also that there must be sustainably managed woodland relatively close to the building site.

Bamboo

Bamboo grows everywhere in the tropics and is therefore available on every continent except Europe. It is a high-quality building material that has a high load-bearing capacity and is very ductile; it is thus on a par with hardwoods or even – because it grows extremely quickly – superior to them. Like wood, bamboo must be treated against pests before use. In many places there are houses, schools, community halls, hotels and churches made entirely of bamboo. Bamboo is often used for ceilings and scaffolding and to bridge large spans. Bamboo is extremely earthquake-resistant. It needs to be protected from wet conditions by means of a roof overhang and stone wall base. High fire protection standards are also required.

Natural and volcanic stone

Natural stone has good heat retention properties. There are many types of stone of varying resistance and solidity. It is important to minimise the energy used in quarrying and transporting the stone. Natural stone can be used both for walls and for the construction of foundations and wall bases – for example, in houses of earth, wood or brick. Working with natural stone is very labour-intensive. Although this creates jobs, it also increases the cost of using stone as a building material, with the amount of the increase depending on wage levels. In some cases the construction of stone walls uses large quantities of cement for the mortar joints.

Obstacles to building with earth and wood as a result of building regulations and building laws

Many building regulations do not permit earthen construction and thus class much of the rural building stock as not compliant with the rules. This is partly the result of misguided concepts of modernity, a rejection of "old-fashioned" traditions of building and inaccurate information about the earthquake resistance of earthen buildings. Similarly, many building codes contain provisos and restrictions on the construction of multi-storey wooden buildings. These provisos relate mainly to fire protection. Building regulations should be updated in line with new insights from science and construction practice. For example, Germany now permits the construction of wooden buildings of up to seven storeys in height after having refused consent for such buildings for decades.

Lack of acceptance of "unusual" building materials and construction methods

People are often reluctant to accept local materials such as earth, wood and bamboo because they are associated with poverty. However, an increasing number of impressive houses are being built with these materials. In these cases, local materials are not being used because they are cheaper but because the resulting quality is first-class. All sections of the population value user-friendly buildings with a pleasant interior climate.

France: This modern-looking house is of prefabricated design and is built using wooden beams and clay. The clay has good insulating properties and absorbs sound.

Photo: Craterre

5. Climate-responsive construction needs change!

Climate-responsive construction needs an appropriate enabling environment and promotion. The right framework enables those involved in the construction process to give priority to climate-friendly solutions. MISEREOR has formulated the following principles that it calls on policy-makers and donor institutions to accept, together with guidelines for the planning and implementation of construction projects:

Principles for policy-maker and donor institutions

1 Environmentally responsible and climate-friendly construction methods should be more strongly promoted. In financially supported construction projects, resource conservation and energy efficiency should be considered over the entire life cycle of the building.
2. In areas where there is a great deal of construction activity, information centres providing advice on opportunities for using local building materials should be set up and supported.
3. Building regulations must permit earthen and wooden construction techniques without imposing objectively unjustified restrictions.
4. Curricula for construction specialists at universities and colleges and continuing training for workers in the construction trades must give appropriate weight to climate-friendly and traditional construction techniques and local building materials.
5. When rebuilding houses after natural disasters, the use of non-industrially produced building materials can enable relief and rehabilitation measures to have a broad impact at low cost. Emergency aid situations must not be a pretext for flying building materials produced in energy-intensive ways into the disaster area.

Guidelines for building projects

1. When planning a building project, consideration must be given to climate change mitigation, resource conservation and energy efficiency at every stage from the production of materials and construction to use and eventual demolition.
2. The feasibility of using locally available building materials such as earth, wood, bamboo or natural stone should always be considered.
3. All options for reducing the overall quantities of building materials and making appropriate use of existing building materials and components, including through recycling, should be thoroughly considered at the planning stage.
4. High quality standards in construction and good maintenance are key factors in prolonging the useful life of buildings.
5. Continued use and conversion should always take priority over demolition and new construction.
6. Needs-driven planning requires the involvement of the future users or their representatives from the same cultural and social milieu.
7. Building projects should create employment opportunities for disadvantaged population groups locally; this may involve using labour-intensive methods. Training, and in particular the training of young people, should be a fixed component of building projects.
8. The health and safety of everyone working on the building project must be protected, partly through strict compliance with safety standards.

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