

Makes use of the entire TNO organization's expertise in giving advice on civil construction, offshore, shipbuilding and

## TNO Building and Construction Research

machine building. Combines many areas of research, such as building and materials technology, fire safety, indoor environment, construction, numerical mechanics, strategic studies and quality assurance.

### Primary fields of activity include:

- structural engineering and design
- materials
- structural testing
- building processes
- fire research
- timber research
- indoor environment, building physics and systems
- mechanical engineering
- strategic studies, quality assurance and building regulations

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*TNO Building and Construction Research has helped to design the Maeslant storm surge barrier which is a vital part of Dutch sea defences. TNO performed a study on the failure characteristics of the structure and researched the greasing of the huge ball hinge (diameter of 13 m) that is used to open and close the barrier.*



## Primary fields of activity in further detail:

### Structural engineering and design

- Structural design and construction technology.
- Final detailing of building components.
- Product innovation.
- Evaluation principles for components of the built environment.

### Materials

- Physical and mechanical properties of materials.
- Moisture transport and thermal insulation.
- Preservation of historic buildings from air pollution.
- Mechanical behaviour of concrete, timber and masonry structures.

### Structural testing

- Reliability of structures, both existing and in design.
- Computing techniques, realistic models, structural details.
- Fire resistance of structures.
- Offshore structures.
- Model testing of structures difficult to analyse.
- Strength and stability of structures.
- Structural details, joints.

### Building processes

- Methodology of the building process and a systems approach to quality control and maintenance.
- Mechanization in building and construction.
- The application of information technology in building:
  - FEM in applied mechanics.
  - linear and non-linear analysis of structures using DIANA, a general purpose finite-element system.
  - utilization of the research results implemented in the product versions of DIANA.
- Dynamic problems: vibration phenomena, wind loading and problems in connection with piling.

- Electronic measuring techniques: pile diagnostic systems, monitoring of structures and integrity tests.

### Fire research

- Research into the causes and consequences of fire.
- Combating fire.
- Fire prevention.
- Behaviour of materials and structures subjected to fire.
- Smoke hazard and smoke spread.
- Fire detection.

### Timber research

- Testing and technical consultancy.
- Structure of wood and identification of wood species.
- Testing of wood, timber structures, furniture and joinery work.
- Drying properties of wood, and advice on kilns.
- Preservation of wood.
- Wood chemistry, including composition, durability, decolourization, bleaching and finishing.
- Wood stabilization.
- Technological timber research: joints and adhesives; timber engineering, sheet materials, and wood waste.
- Quality and tolerance: finishes for surfaces using paints, varnishes, and foils.

### Indoor environment, building physics and systems

- Physical and chemical aspects of the working environment in industry and in public utility buildings; technical solutions and policy studies.
- Indoor climate quality in homes; chemical and biological contamination; indoor climate control systems: humidity and dust control; ventilation problems.
- Relationships between indoor environmental quality and energy consumption.
- Heat technology: energy saving, solar energy, heat storage, building physics.

- Acoustics of buildings and rooms.
- Lighting: daylight and electric lighting; electronic control of light; design of combined daylight and electric lighting conditions.

### Mechanical engineering

- Fatigue, collapse and unwanted structuro-dynamic behaviour.
- New design techniques for structures and machines.
- Determination, assessment and optimization of mechanical behaviour of structures, installations and equipment with respect to safety, reliability, efficiency, durability and the environment.
- Design and construction of special-purpose test machines, for example shock testing.
- Design to protect against underwater explosion and shock; design of proper shock specifications, laboratory testing of shock resistance and field measurements during shock testing of ships at sea.
- Design-oriented R&D on composites for naval ships, offshore installations (housing) and the building industry.
- Non-linear dynamics of rotating equipment and robot components; worldwide field measurements of mass, strain, stress, pressure, force acceleration, and velocity of displacement.
- Development of condition monitoring systems for rotating equipment on the basis of measurement techniques, tribology, structural mechanics and computer technology.

### Strategic studies, quality assurance and building regulations

- Literature surveys, problem analysis, auditing, research programmes, strategic planning.
- Models for quality management (MKS intellect).