COVER / OVERVIEW

# Zero Tolerance. Infinite Cycle.

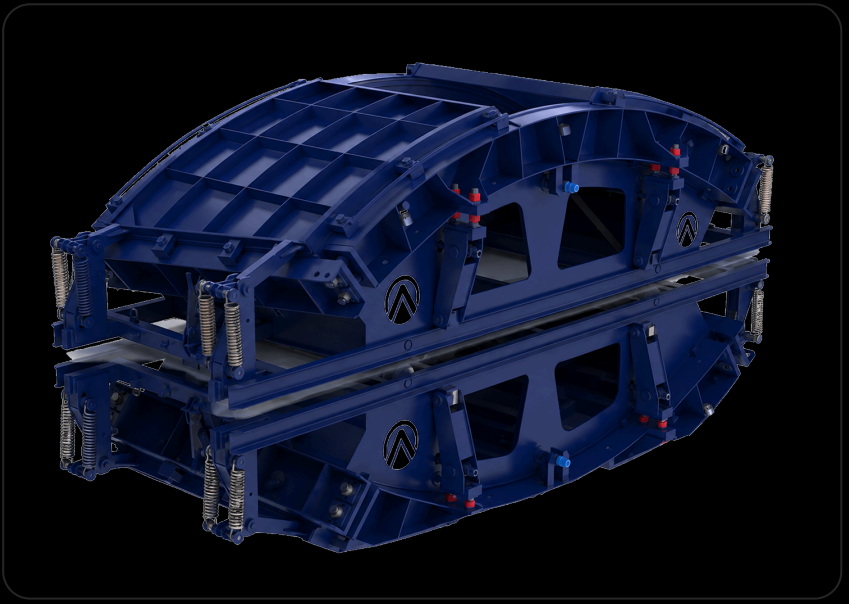
## Precast Tunnel Segments & Industrial Plant Architecture

Zero-tolerance mould sets, fully automated carousel lines, and turnkey stationary plant solutions engineered for precast concrete segments powering modern TBM drives worldwide.

MACHINING ACCURACY
**±0.3 mm**
5-axis CNC finished contact faces

DESIGN LIFE
**100 Years**
DIN EN 1992-1-1 infrastructure standard

DAILY OUTPUT
**120+ Rings**
Continuous casting via carousel automation



ENGINEERING PHILOSOPHY & NORMS

# DIN EN Standards & The Zero Tolerance Rule

Sub-Millimeter Precision in Tunnel Structural Integrity

> Under thousands of tonnes of thrust jack loads delivered by the TBM, precast segments must interlock with zero planar deviation. A fraction of a millimeter distortion will tear EPDM gaskets and cause catastrophic water ingress.

GLOBAL NORM

### DIN EN 1992-1-1 & DAUB Recommendations

Full conformance with International Tunnelling Association guidelines, engineered to withstand extreme anisotropic ground loads.

METROLOGY

### Laser Interferometer Verification

Every mould frame undergoes 3D coordinate laser metrology post machining. Angularity and taper are certified strictly within 0.3 mm.

WATERTIGHT

### Integral EPDM Gasket Groove Geometry

Precision CNC milled gasket seats ensuring watertight seal alignment during aggressive compaction and thermal curing.

RADIAL DEVIATION

**< 0.4 mm —** Seamless ring closure

HYDROSTATIC SEAL

**8.0+ Bar —** Joint watertight reliability

PLANT ARCHITECTURE 01

# Stationary Plants (Fixed Bed Systems)

Rapid Deployment & Ultimate Job-Site Adaptability

A modular casting facility composed of independent heavy-duty mould stations designed for limited job-site footprints, shorter tunnel alignments, or expedited mobilization schedules.

**Modular Capital Investment & Fast Erection** — Installation: 3–4 Weeks

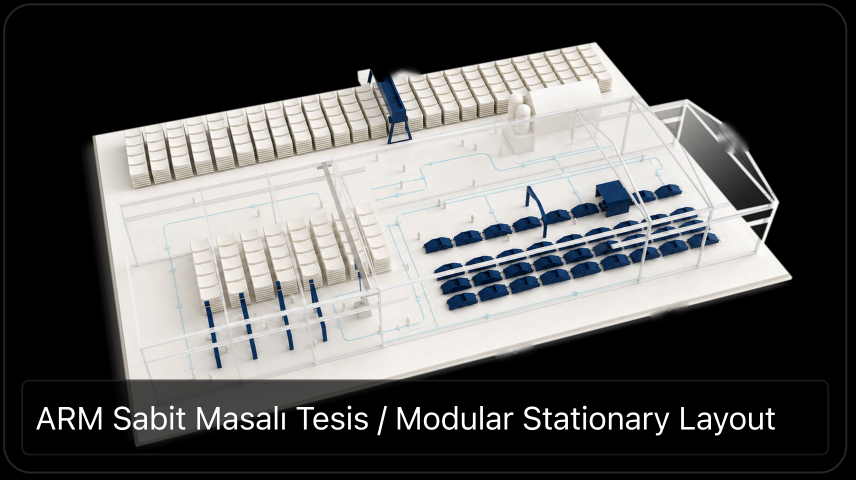
Commissionable within 3 to 4 weeks on simple slab foundations without demanding colossal covered hall complexes.

**Steam & Thermal Oil Bed Heating** — Stripping: 10–12 Hours

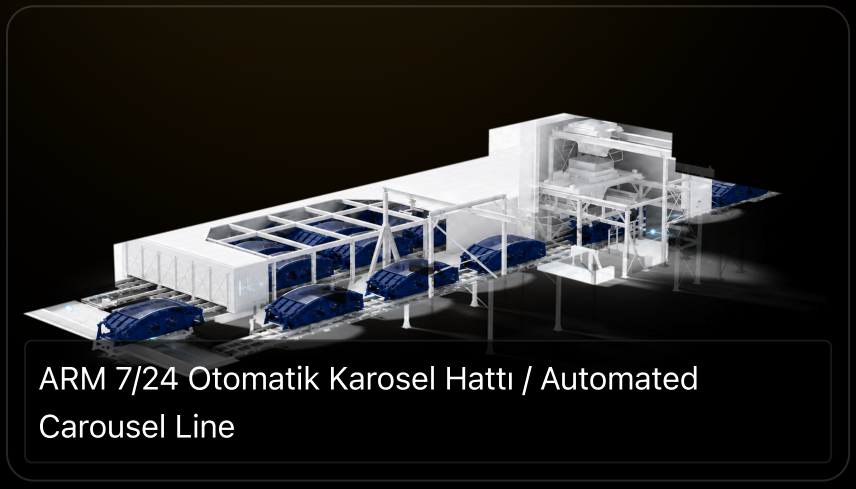
Integrated serpentine jackets beneath each mould base yield dependable 10-12 hour stripping cycles regardless of ambient winter frost.

**Gantry Crane & Shuttled Distributor** — Minimal Labor Footprint

Direct integration with automated flying buckets and radio-controlled overhead cranes for lean staffing operations.



ARM Sabit Masalı Tesis / Modular Stationary Layout



ARM 7/24 Otomatik Karosel Hattı / Automated Carousel Line

PLANT ARCHITECTURE 02

## Fully Automated Carousel Lines

24/7 Continuous Loop for High-Speed Metro & Rail Mega-Projects

An Industry 4.0 segment manufacturing complex where moulds circulate on powered roller tracks across robotized stations and multi-tier accelerated steam curing chambers.

**Synchronous Multi-Station Flow** — AUTOMATION

Autonomous mould opening, high-pressure release oil misting, rebar cage insertion, compaction, curing, and demoulding.

**Multi-Tier Automated Curing Chambers** — FAST CURING

Microclimate PLC feedback governing thermodynamic curves, enabling demoulding strength (15 MPa) within just 6 to 8 hours.

**High-Volume Ring Output** — PEAK CAPACITY

Delivers 80 to 120+ complete precast rings per 24h cycle, perfectly pacing double-shield and EPB mega TBM advance records.

DIGITAL TELEMETRY & TRACEABILITY

# Integrated SDS & RFID Shaft Telemetry

End-to-End Traceability From Concrete Batching to TBM Erector

Embedded RFID and QR sensors track the complete life cycle of every individual segment in real-time, connecting production telemetry straight to the TBM tunnel guidance system.

### Hydration & Thermal Telemetry

QA ARCHIVE

Sensors continuously record temperature evolution, relative humidity, and maturity indices during active steam curing.

### Smart Yard Mapping & Curing Age

YARD LOGISTICS

Algorithmic inventory layout optimizes stacking order, minimum curing maturation, and shaft delivery sequence.

### TBM Guidance Synchronicity

SCADA DRIVEN

Real-time communication with the tunnel boring machine calls the exact segment ring pattern (universal, left, right, key) just-in-time.




SCADA & Real-Time Shaft Logistics Protocol

AUXILIARY PLANT MACHINERY

# Heavy-Duty Auxiliary Plant Equipment

Gentle Handling, 180° Inversion & Mould Maintenance Systems

Dedicated handling and surface conditioning machinery engineered to safeguard fresh green concrete from micro-cracking and preserve mould tolerances over 100,000 cycles.

### Vacuum Segment Lifter

Payload: 16 Tonnes

Dual-circuit fail-safe vacuum technology capable of picking fresh concrete segments up to 16 metric tonnes without structural stress.

CE / EN ISO 12100 SAFETY PLC READY

### 180° Hydraulic Segment Turner

Cycle: 180° in 45 sec

Inverts segments smoothly from extrusion position to upright storage attitude with proportional hydraulic damping.

CE / EN ISO 12100 SAFETY PLC READY

### Automated Cleaning & Release Oil Station

Oil Economy: 40%

Closed robotic booth spraying micron-thin, perfectly uniform biodegradable parting agent on all contact surfaces.

CE / EN ISO 12100 SAFETY PLC READY

### Heavy-Duty Transfer Cars & Gantry Rails

Rating: 30+ Tonnes

Rugged railway transfer bogeys and electric gantry rail lines for smooth transport between hall, curing, and storage.

CE / EN ISO 12100 SAFETY PLC READY

ENGINEERING COMPARISON

# Two Plant Architectures, One Engineering Excellence

Stationary Fixed-Bed vs. Fully Automated Carousel System Matrix

Detailed technical comparison enabling project owners and joint ventures to align production mechanics with route length, capital budgeting, and logistics constraints.

| Criterion / Parameter | Stationary Plant (Fixed Bed) | Fully Automated Carousel |
|---|---|---|
| Target Tunnel Alignment | 1,000 m – 6,000 m | **6,000 m – 35,000+ m** |
| Daily Ring Output | 15 – 35 Rings / Day | **60 – 120+ Rings / Day** |
| Capital Expenditure (CAPEX) | Low / Moderate | **High (Rapidly amortized on mega drives)** |
| Required Footprint | Compact (Flexible outdoor/hall) | **Expansive Industrial Hall (Min 100m)** |
| Labor Intensity | Moderate Crew | **Minimal (Robotics & PLC Automation)** |
| Curing Method | Internal Steam / Thermal Jackets | **Automated Multi-Tier Thermal Tunnel** |
| Demoulding Strength Window | 10 – 12 Hours | **5 – 7 Hours** |
| Mobilization & Commissioning | 3 – 4 Weeks | **8 – 12 Weeks** |

GLOBAL QUALITY & SERVICE

# Global Commissioning, Lifetime Service & Parts

## Your Reliable 24/7 Underground Engineering Partner Worldwide

From initial mould finite element stress analysis to on-site commissioning, operator certification, and worldwide 24/7 wear-part dispatch, ARM stands behind every ring built.

| FLAGSHIP PROJECTS | FIELD RESPONSE | FRAME WARRANTY |
|---|---|---|
| **45+** | **< 24 Hours** | **36 Months** |
| Metro, high-speed rail, hydro and utility tunnels | Global rapid deployment of field engineers | Structural mechanical chassis guarantee |

**Turnkey On-Site Mobilization**
Complete civil supervision from anchor bolt placement to the inaugural trial casting and laser verification.

**SCADA & Operator Certification**
Comprehensive hands-on training for client technicians, plant operators, and quality controllers.

**Headquarters & Heavy Plant**
Inonu Mah. Sanayi Cad. No:48 Dilovasi / Kocaeli / TURKIYE
info@armtunnel.com | +90 (262) 500 00 00

**ARM TUNNEL**
HEAVY INDUSTRY & TUNNEL SYSTEMS

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