NESANS

EQUIPMENT SELECTION

Screen Deck Configuration: Single vs. Double vs. Triple Deck Analysis for 5mm-20mm Aggregate Production

Compare single, double, triple deck screens for 5mm-20mm aggregate. Optimize deck setup for maximum efficiency and product quality.

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Your plant produces 5-10mm, 10-15mm, and 15-20mm aggregates using three separate single-deck screens—requiring 85m² total screening area and complex material flow. Switching to a single triple-deck screen (35m² area) produces all three sizes simultaneously with 15-20% higher efficiency, ₹18 lakh lower capital cost, and 40% reduced maintenance. The key: understanding deck configuration trade-offs—single-deck offers simplicity, double-deck handles two-product separation efficiently, and triple-deck maximizes multi-product screening in minimum space. Selecting optimal configuration for your production requirements reduces capital cost per ton of capacity by 35-45% while improving screening efficiency.

Screen deck configuration—the number and arrangement of screening surfaces within a single machine—fundamentally determines screening efficiency, capital cost, and operational complexity. A single-deck screen separates material into two products (oversize and undersize). A double-deck screen creates three products, and a triple-

deck produces four products. Yet the relationship between deck quantity and performance isn't linear: adding decks increases separation capacity but reduces individual deck efficiency due to reduced material stratification and overloading of lower decks with fines. Optimal configuration balances product requirements, throughput targets, and economic constraints.

This guide analyzes single, double, and triple-deck screen configurations for producing 5-20mm aggregate products, examining efficiency trade-offs, capacity calculations, capital and operating costs, and application-specific selection criteria that minimize total cost per ton of screened product.

Screen Deck Fundamentals

How Multi-Deck Screening Works

Screening Process Sequence:

- Material fed onto top deck at feed end
- Top deck separates largest size fraction (first cut)
- Oversize discharges from top deck as product #1
- Undersize from top deck feeds second deck
- Second deck separates intermediate size (second cut)
- Oversize from second deck = product #2, undersize feeds third deck (if present)
- Process continues through all decks
- Bottom deck undersize = finest product

Example: Triple-Deck Screen Producing 5-20mm Aggregates:

- **Feed:** 0-25mm crushed material
- **Top Deck (20mm aperture):** Retains 20-25mm material (rejects as oversize to crusher)
- **Middle Deck (15mm aperture):** Retains 15-20mm material (Product #1)
- **Lower Deck (10mm aperture):** Retains 10-15mm material (Product #2)
- **Bottom Pan (5mm aperture):** Retains 5-10mm material (Product #3), passes 0-5mm as fines/M-sand

Stratification and Screening Efficiency

Screening efficiency depends on particle stratification—the natural segregation that occurs as material travels across vibrating screen surface. Fine particles migrate downward through voids between coarse particles, concentrating near the screen surface where they can pass through apertures. Coarse particles remain on top, eventually discharging as oversize.

Stratification Requirements:

- **Material Depth:** 2-4 times maximum particle size for effective stratification (deeper beds improve stratification but reduce efficiency)
- **Particle Size Range:** Best efficiency when feed contains 3-6× size ratio (e.g., screening 20mm from 0-25mm feed is easier than 5mm from 0-100mm feed)
- **Travel Distance:** Minimum 2-3 meters deck length for complete stratification and separation
- **Vibration Intensity:** 3-6 G (gravities) acceleration promotes stratification without excessive material bouncing

Multi-Deck Stratification Challenges:

- Each deck receives pre-classified feed from the deck above
- Lower decks handle progressively finer material with narrower size range
- Fine material has lower stratification rate (particles similar size, less void space)
- Lower decks loaded with higher percentage of near-size particles (hard to separate)
- Result: Top deck typically achieves 90-95% efficiency, bottom deck achieves 75-85% efficiency

Configuration Analysis: Single, Double, Triple-Deck Comparison

Single-Deck Screen

Configuration:

- One screening surface, produces two products (oversize and undersize)

- Example application: Separating 20mm from crusher discharge (20+ oversize to recirculate, -20mm as product)
- Typical aperture: One size only

Performance Characteristics:

- **Screening Efficiency:** 92-98% (highest of any configuration due to optimal stratification)
- **Capacity:** 8-12 tons/hr/m² for 20mm separation, 4-6 tons/hr/m² for 5mm separation
- **Simplicity:** Easiest to operate, minimal maintenance, clearest troubleshooting
- **Flexibility:** Simple aperture changes allow quick product size adjustment

Advantages:

- Maximum screening efficiency—optimal stratification with single separation
- Lowest maintenance (one deck to monitor, clean, replace)
- Highest throughput per unit area for single separation
- Simplest material flow—minimal chute complexity

Disadvantages:

- Limited product flexibility—only two products per screen
- Multiple screens required for multi-product plants (high capital cost, large footprint)
- Complex material routing between screens

Best Applications:

- Scalping oversized material before crusher
- Closed-circuit crushing (separating crusher discharge from finished product)
- Single-product operations (e.g., producing only 10-20mm aggregate)
- When maximum efficiency critical (premium product quality requirements)

Double-Deck Screen

Configuration:

- Two screening surfaces, produces three products

- Example: Top deck 15mm, bottom deck 5mm → Products: +15mm (oversize), 5-15mm (middle), -5mm (fines)
- Most common configuration for aggregate plants

Performance Characteristics:

- **Screening Efficiency:** Top deck 90-95%, bottom deck 82-90%
- **Capacity:** Top deck 7-10 tons/hr/m², bottom deck 5-8 tons/hr/m² (lower deck becomes limiting)
- **Product Flexibility:** Three products from single machine (good for most applications)
- **Material Flow:** Moderate complexity, manageable chute arrangements

Advantages:

- Optimal balance of efficiency, capacity, and product flexibility
- Lower capital cost than two single-deck screens (40-50% savings)
- Compact footprint—half the area of two singles
- Good efficiency on both decks (top deck excellent, bottom deck good)
- Standard design with proven reliability

Disadvantages:

- Bottom deck efficiency 5-10% lower than single-deck equivalent
- Screen media changes more labor-intensive (two decks to access)
- Limited to three products—insufficient for complex product ranges

Best Applications:

- Producing two aggregate sizes plus fines (most common requirement)
- Medium-capacity plants (100-300 TPH)
- When footprint or capital cost constrained vs. single-deck alternative
- Standard aggregate production for ready-mix or asphalt applications

Triple-Deck Screen

Configuration:

- Three screening surfaces, produces four products

- Example: Top 20mm, middle 15mm, lower 10mm, bottom 5mm → Products: +20mm, 15-20mm, 10-15mm, 5-10mm, -5mm
- Maximum product flexibility in single machine

Performance Characteristics:

- **Screening Efficiency:** Top deck 88-94%, middle deck 80-88%, bottom deck 70-82%
- **Capacity:** Top deck 6-9 tons/hr/m², middle deck 5-7 tons/hr/m², bottom deck 3-5 tons/hr/m²
- **Product Flexibility:** Four products from single machine (maximum versatility)
- **Complexity:** Higher maintenance requirements, complex chute arrangement

Advantages:

- Maximum product range from single machine (four size fractions)
- Lowest capital cost per product (vs. multiple single or double-deck screens)
- Minimal footprint for multi-product operations
- Simplified plant layout—single feed point, four discharge points

Disadvantages:

- Lowest bottom deck efficiency (70-82% vs. 92-98% for equivalent single-deck)
- Bottom deck capacity limitation—often undersized relative to plant capacity
- Complex maintenance (three decks to access, replace, tension)
- Difficult troubleshooting (identifying which deck underperforming)
- Higher screen media cost (three full decks)

Best Applications:

- Multi-product plants requiring 4-5 size fractions
- Space-constrained sites where footprint critical
- When capital cost per product is limiting factor
- Mobile or portable plants requiring maximum versatility in compact package

Capacity Calculations and Sizing

Throughput Determination

Base Capacity Formula:

Capacity (tons/hr) = Screen Area (m^2) × Basic Capacity Factor (tons/hr/m^2) × Correction Factors

Basic Capacity Factors (for aggregate, 2.5-3 G acceleration, 50% passing screen aperture):

- **5mm aperture:** 4.5-6.5 tons/hr/m^2
- **10mm aperture:** 6-8 tons/hr/m^2
- **15mm aperture:** 7-9.5 tons/hr/m^2
- **20mm aperture:** 8-11 tons/hr/m^2
- **40mm aperture:** 10-14 tons/hr/m^2

Correction Factors:

- **Deck Position:** Top deck = 1.0, middle deck = 0.85-0.90, bottom deck = 0.70-0.80
- **Percentage Oversize:** If 70% oversize (30% passing), multiply by 1.15; if 30% oversize (70% passing), multiply by 0.85
- **Material Density:** Standard assumes 1.6 t/m^3 bulk density; for lighter material (1.3 t/m^3), multiply by 0.81
- **Moisture:** Dry material = 1.0, 3-5% moisture = 0.85, 6-10% moisture = 0.65
- **Deck Inclination:** Optimal (20-25°) = 1.0, flat (10-15°) = 0.80, steep (30-35°) = 1.10

Example Sizing Calculation

Requirement: Screen 150 TPH crusher discharge (0-25mm) into four products: +20mm, 15-20mm, 10-15mm, 5-10mm, -5mm fines

Feed Gradation:

- 10% passing 5mm
- 25% passing 10mm

- 50% passing 15mm
- 75% passing 20mm
- 100% passing 25mm

Triple-Deck Sizing:

Top Deck (20mm aperture):

- Feed: 150 TPH, 75% passing (113 TPH undersize), 25% oversize (37 TPH oversize)
- Base capacity: 9.5 tons/hr/m² (20mm aperture)
- Deck position factor: 1.0 (top deck)
- Oversize factor: 1.05 (25% oversize is near optimal)
- Effective capacity: 9.5 × 1.0 × 1.05 = 10.0 tons/hr/m²
- Required area: 150 TPH / 10.0 = 15 m²

Middle Deck (15mm aperture):

- Feed: 113 TPH from top deck, 50/75 = 67% passing, 33% oversize
- Base capacity: 8.2 tons/hr/m²
- Deck position factor: 0.88 (middle deck)
- Oversize factor: 1.08 (33% oversize)
- Effective capacity: 8.2 × 0.88 × 1.08 = 7.8 tons/hr/m²
- Required area: 113 TPH / 7.8 = 14.5 m²

Bottom Deck (10mm aperture):

- Feed: 75 TPH from middle deck, 25/50 = 50% passing, 50% oversize
- Base capacity: 7.0 tons/hr/m²
- Deck position factor: 0.75 (bottom deck)
- Oversize factor: 1.0 (50% passing is base assumption)
- Effective capacity: 7.0 × 0.75 × 1.0 = 5.25 tons/hr/m²
- Required area: 75 TPH / 5.25 = 14.3 m²

Final Pan (5mm aperture):

- Feed: 37.5 TPH from bottom deck, 10/25 = 40% passing, 60% oversize
- Base capacity: 5.5 tons/hr/m²

- Deck position factor: 0.70 (lowest deck)
- Oversize factor: 1.12 (60% oversize)
- Effective capacity: 5.5 × 0.70 × 1.12 = 4.3 tons/hr/m²
- Required area: 37.5 TPH / 4.3 = 8.7 m²

Conclusion: Middle deck requires largest area (14.5 m²). Select standard screen with 18-20 m² area (e.g., 2.4m wide × 7.5m long = 18 m² with 20% oversize margin). This provides 15-25% safety factor on all decks.

Cost Comparison Analysis

Capital Cost Comparison

Scenario: Producing Three Aggregate Sizes (5-10mm, 10-15mm, 15-20mm) from 0-25mm Feed at 120 TPH

Option 1: Three Single-Deck Screens (Series Configuration):

- Screen #1 (20mm cut): 15 m², ₹22 lakhs
- Screen #2 (15mm cut): 14 m², ₹20 lakhs
- Screen #3 (10mm cut): 13 m², ₹19 lakhs
- Inter-screen conveyors: 3 units × ₹5 lakhs = ₹15 lakhs
- Product discharge conveyors: 4 units × ₹4 lakhs = ₹16 lakhs
- **Total capital: ₹92 lakhs**
- Footprint: 85 m² (3 screens + conveyors)
- Installation time: 8-12 weeks

Option 2: One Triple-Deck Screen:

- Triple-deck screen (18 m² total, 3× 6m² decks): ₹38 lakhs
- Feed conveyor: ₹5 lakhs
- Product discharge conveyors: 4 units × ₹4 lakhs = ₹16 lakhs
- **Total capital: ₹59 lakhs (36% savings vs. three singles)**
- Footprint: 35 m² (59% reduction)
- Installation time: 3-4 weeks

Option 3: Two Double-Deck Screens:

- Double-deck screen #1 (20mm/15mm, 16 m²): ₹28 lakhs
- Double-deck screen #2 (10mm/5mm, 15 m²): ₹26 lakhs
- Inter-screen conveyor: ₹5 lakhs
- Product discharge conveyors: 5 units × ₹4 lakhs = ₹20 lakhs
- **Total capital: ₹79 lakhs (14% savings vs. three singles, 34% more than triple-deck)**
- Footprint: 55 m² (35% reduction vs. singles)
- Installation time: 5-7 weeks

Operating Cost Comparison

Annual Operating Costs (120 TPH, 7,200 hours/year = 864,000 tons):

Three Single-Deck Screens:

- Power consumption: 3 screens × 45 kW × 7,200 hrs × ₹6.5/kWh = ₹6.32 lakhs
- Screen media replacement: 42 m² × ₹450/m² × 2 changes/year = ₹3.78 lakhs
- Bearing/drive maintenance: 3 units × ₹35,000/year = ₹1.05 lakhs
- **Total operating cost: ₹11.15 lakhs/year (₹1.29/ton)**

One Triple-Deck Screen:

- Power consumption: 1 screen × 75 kW × 7,200 hrs × ₹6.5/kWh = ₹3.51 lakhs
- Screen media replacement: 54 m² (3× 18m² decks) × ₹450/m² × 2.5 changes/year = ₹6.08 lakhs
- Bearing/drive maintenance: 1 unit × ₹45,000/year = ₹0.45 lakhs
- **Total operating cost: ₹10.04 lakhs/year (₹1.16/ton, 10% savings)**

Two Double-Deck Screens:

- Power consumption: 2 screens × 55 kW × 7,200 hrs × ₹6.5/kWh = ₹5.15 lakhs
- Screen media replacement: 62 m² × ₹450/m² × 2.3 changes/year = ₹6.42 lakhs
- Bearing/drive maintenance: 2 units × ₹40,000/year = ₹0.80 lakhs
- **Total operating cost: ₹12.37 lakhs/year (₹1.43/ton, 28% more than triple-deck)**

Selection Criteria and Decision Matrix

When to Use Single-Deck Configuration

Ideal Scenarios:

- Producing only 1-2 aggregate sizes (e.g., scalping oversize, separating sand from coarse aggregate)
- Maximum screening efficiency required (>95% target)
- Very fine separations (<3mm) where multi-deck inefficiency problematic
- Sufficient space and capital for multiple screening stages
- Modular plant design allowing capacity expansion by adding screens

Avoid Single-Deck When:

- Producing 3+ size fractions (capital cost prohibitive)
- Space constrained (large footprint requirement)
- Complex material routing undesirable

When to Use Double-Deck Configuration

Ideal Scenarios:

- Producing 2-3 aggregate sizes (most common requirement)
- Medium to large capacity (100-500 TPH)
- Balancing capital cost vs. efficiency (optimal compromise)
- Standard aggregate production for ready-mix, asphalt, concrete block
- Replacement for aging single-deck systems (capacity upgrade in same footprint)

Avoid Double-Deck When:

- Requiring 4+ product sizes (insufficient flexibility)
- Very high efficiency critical on all separations (bottom deck compromised)
- Very fine bottom deck separation (<5mm in high-tonnage application)

When to Use Triple-Deck Configuration

Ideal Scenarios:

- Producing 4-5 product sizes from single screen
- Severe space constraints (minimal footprint available)
- Capital cost minimization priority (lowest cost per product)
- Mobile or portable plants (maximum versatility in compact unit)
- Lower-capacity applications (<200 TPH) where bottom deck inefficiency manageable

Avoid Triple-Deck When:

- High tonnage with fine bottom deck separation (bottom deck becomes bottleneck)
- Maximum efficiency critical (bottom deck only 70-82% efficient)
- Maintenance resources limited (complex serviceability)
- Fine material (<5mm) represents >40% of feed (overloads bottom decks)

Hybrid Configuration Strategies

Combining Configuration Types

Strategy 1: Primary Double-Deck + Secondary Single-Deck:

- Double-deck scalps oversize and makes coarse product
- Undersize from double-deck feeds single-deck for fine separation
- Achieves 4 products with better efficiency than pure triple-deck
- Example: Double-deck (20mm/10mm top/bottom) + Single-deck (5mm) = 4 products
- Cost between double-deck and triple-deck options
- Best for applications where fine product requires high efficiency

Strategy 2: Parallel Double-Decks (Redundancy):

- Two identical double-deck screens in parallel
- Each handles 50% of throughput

- Provides maintenance flexibility (one screen down, plant continues at 50% capacity)
- Higher capital cost but eliminates single-point-of-failure risk
- Justified for critical operations (asphalt plants, large ready-mix producers)

Implementation Recommendations

For New Plants (Green Field):

- Survey market to determine required product range (2-3 sizes vs. 4-5 sizes)
- Calculate future capacity requirements (plan for 50% growth over 5 years)
- If producing 2-3 sizes: Select double-deck configuration (optimal efficiency-cost balance)
- If producing 4-5 sizes: Evaluate triple-deck vs. double-deck + single-deck hybrid
- Ensure adequate space for product discharge conveyors and surge bins

For Retrofit/Replacement:

- Measure available footprint precisely (including access for maintenance)
- If replacing multiple single-decks: Strong case for consolidation into double or triple-deck
- If space-constrained: Triple-deck may be only option despite efficiency compromise
- Consider phased implementation (replace one screen, operate hybrid system temporarily)

Conclusion

Screen deck configuration selection requires balancing product requirements, screening efficiency, capital cost, and operational complexity. Single-deck screens achieve maximum efficiency (92-98%) but require multiple units for multi-product plants, increasing capital cost 55-75% vs. integrated alternatives. Double-deck screens represent the optimal compromise for most applications—producing three size fractions with 82-95% efficiency at 40-50% lower capital cost than three singles. Triple-

deck screens maximize product flexibility (four sizes) and minimize capital cost per product but sacrifice bottom deck efficiency (70-82%), making them suitable for lower-tonnage multi-product applications or space-constrained installations.

For a typical 120 TPH aggregate plant producing three size fractions, triple-deck configuration saves ₹33 lakhs capital (36% reduction) and ₹1.1 lakhs annual operating cost (10% reduction) vs. three single-deck screens—achieving payback in immediate capital savings while reducing footprint 59%. However, if requiring maximum fine product quality or processing high-tonnage with significant fine content, double-deck or hybrid configurations justify their 25-35% capital premium through superior bottom-end screening efficiency.

The key insight: adding screen decks doesn't proportionally increase capability—each additional deck reduces incremental efficiency by 8-15%. Select minimum deck quantity that meets product requirements, maximizing individual deck performance rather than maximizing deck count.

Topics: #Screening #material separation #screening efficiency #vibrating screen

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