

Asphalt Concrete Mix Design

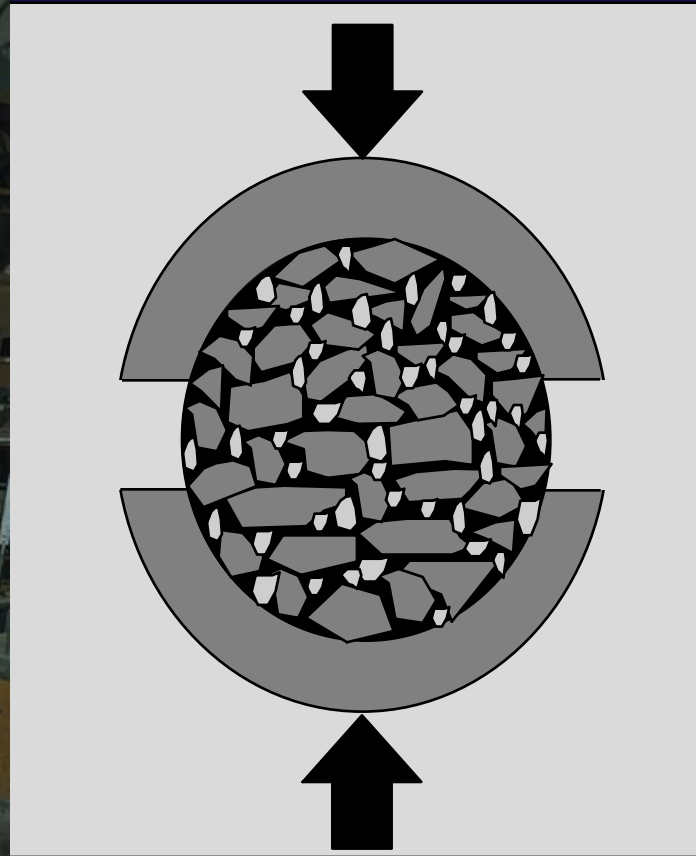
Hot Mix Asphalt Concrete (HMA) Mix Designs

- Objective:
 - Develop an economical blend of aggregates and asphalt that meet design requirements
- Historical mix design methods
 - Marshall
 - Hveem
- New
 - Superpave gyratory

Mix Design Objectives

- Sufficient asphalt to ensure a durable pavement
- Sufficient stability under traffic loads
- Sufficient air voids
 - Upper limit to prevent excessive environmental damage
 - Lower limit to allow room for initial densification due to traffic
- Sufficient workability

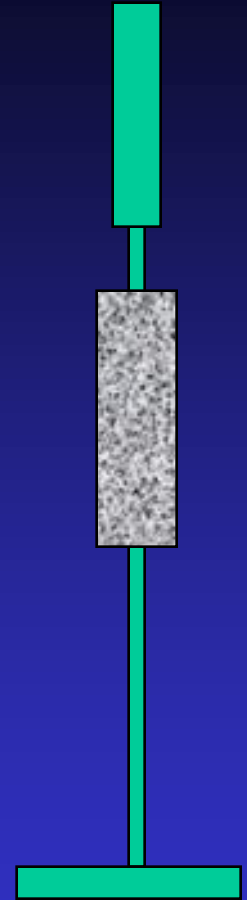
MARSHALL MIX DESIGN



Specimen size 102 x 64 mm

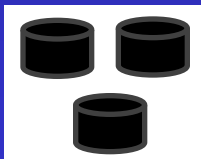
Marshall Mix Design

- Developed by Bruce Marshall for the Mississippi Highway Department in the late 1930's
 - No. of blows,
 - Decided on 10 lb.. Hammer, 50 blows/side
 - 4% voids after traffic
- Initial criteria were established and upgraded for increased tire pressures and loads

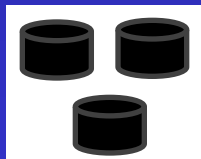


Marshall Mix Design

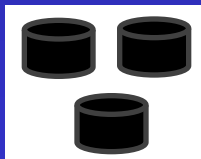
- Select and test aggregate
 - Select and test asphalt cement
 - Establish mixing and compaction temperatures
 - Develop trial blends
 - Heat and mix asphalt cement and aggregates
 - Compact specimen (102 mm diameter)
-



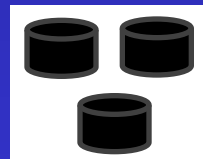
bit. = 4%



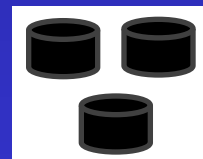
bit. = 4.5%



bit. = 5%



bit. = 5.5%

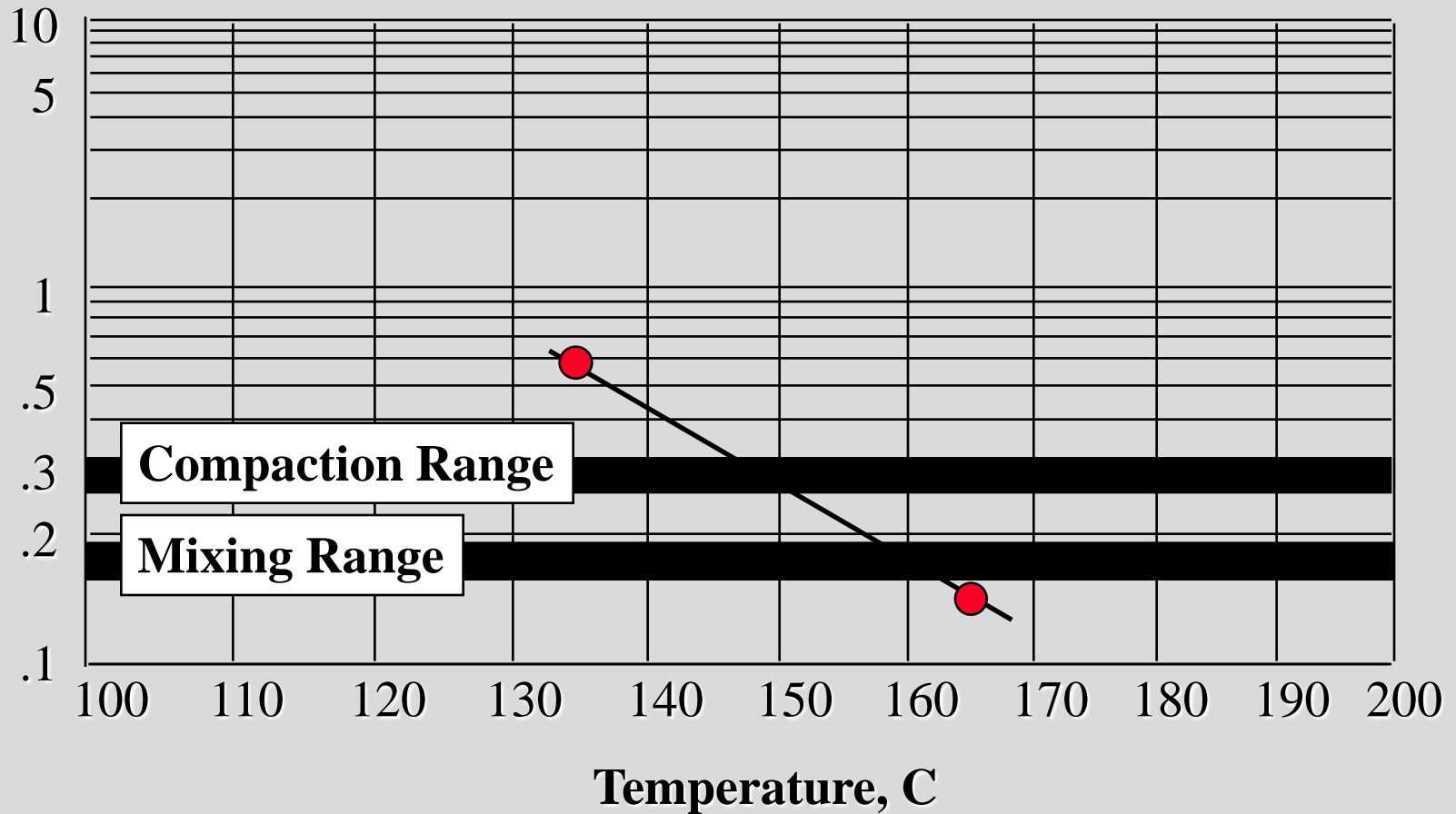


bit. = 6%

(Just an example)

Mixing / Compaction Temps

Viscosity, Pa s

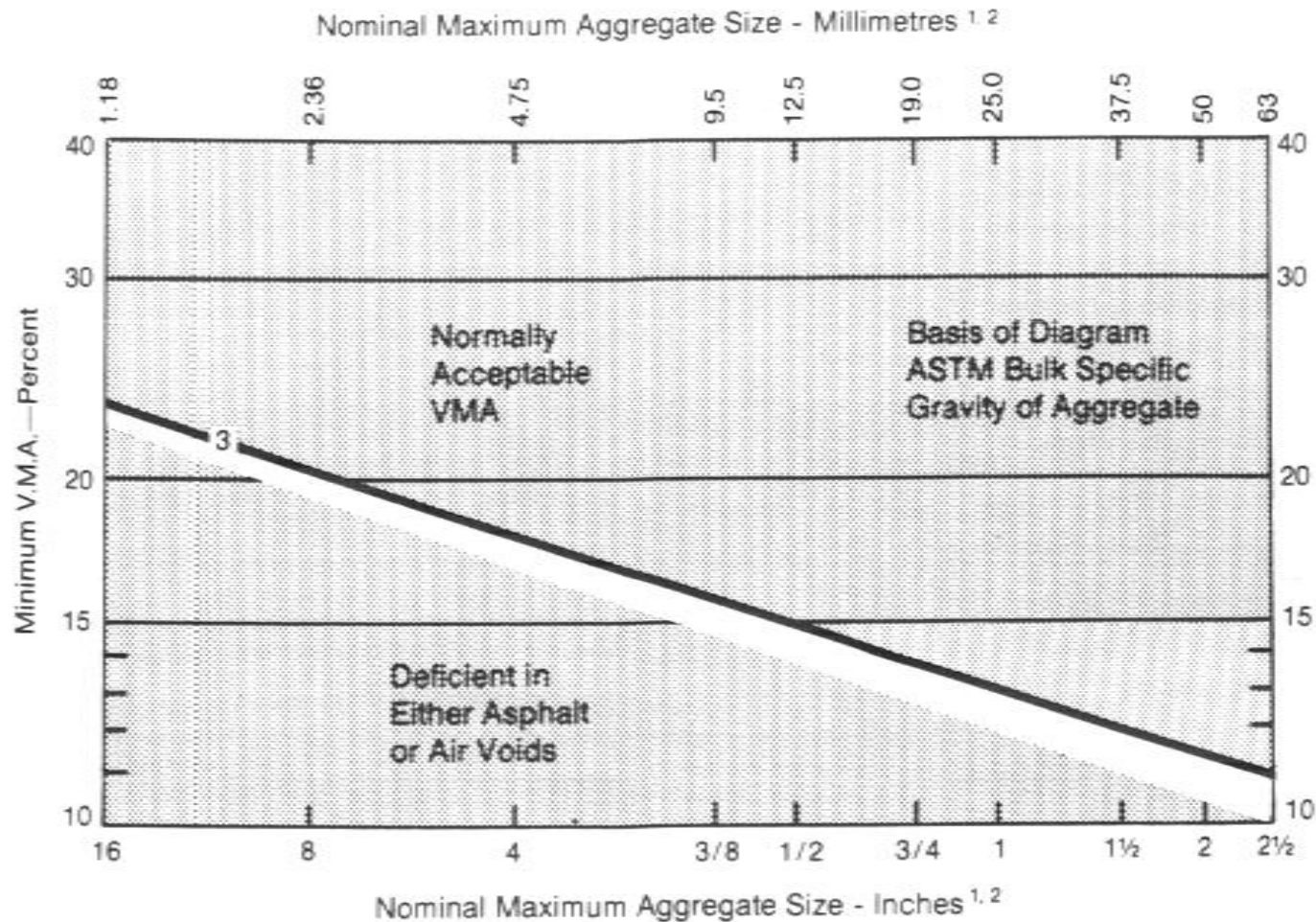


Marshall Design Criteria

	Light Traffic ESAL < 10 ⁴	Medium Traffic 10 ⁴ < ESAL < 10 ⁵	Heavy Traffic ESAL > 10 ⁶
Compaction	35	50	75
Stability N (lb.)	3336 (750)	5338 (1200)	8006 (1800)
Flow, 0.25 mm (0.1 in)	8 to 18	8 to 16	8 to 14
Air Voids, %	3 to 5	3 to 5	3 to 5
Voids in Mineral Agg. (VMA)	Varies with aggregate size		

These criteria can slightly vary between various regions

Minimum VMA Requirements



Marshall Mix Design Tests

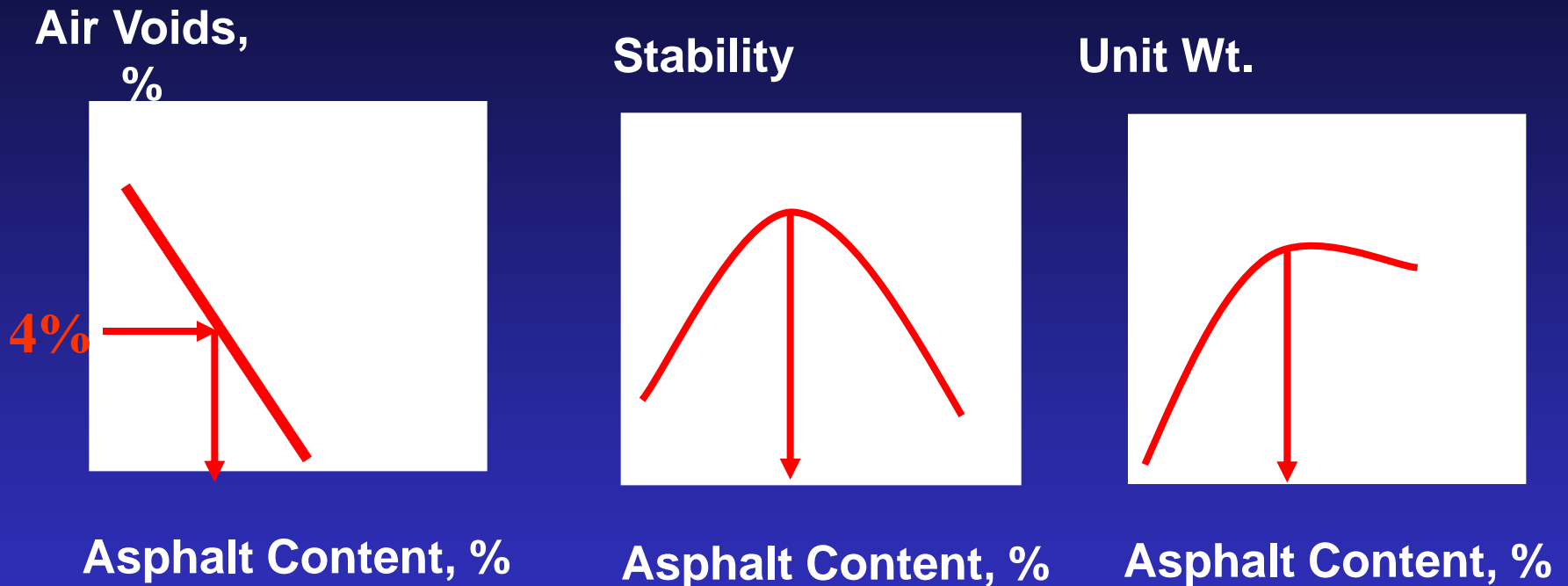
- Heights of samples
 - Used to correct stability measurements
- Bulk specific gravity of compacted sample
- Maximum specific gravity of loose mix
- Stability and flow
 - 60°C water bath (30 to 40 minutes)
 - 50 mm/min loading rate
 - Max. load = uncorrected stability
 - Corresponding vertical deformation = flow

Marshall Stability and Flow



Marshall Design Use of Data

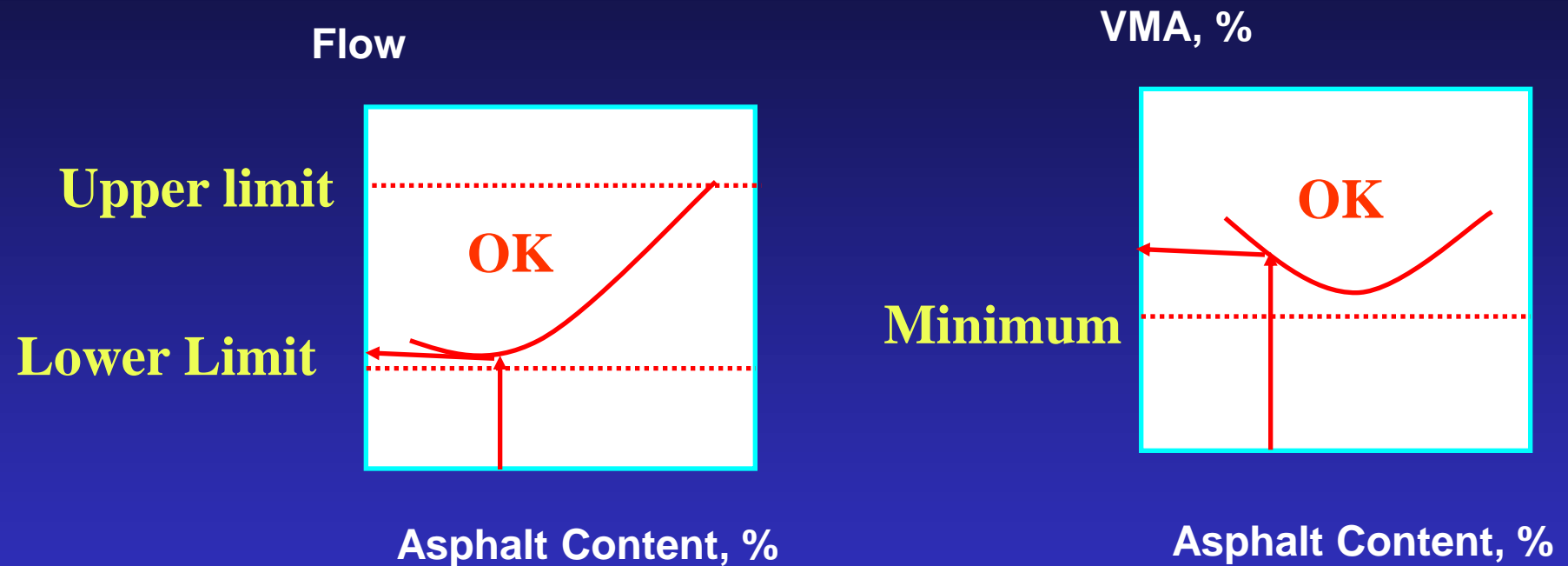
Asphalt Institute Procedure



Target optimum asphalt content = average

Marshall Design Use of Data

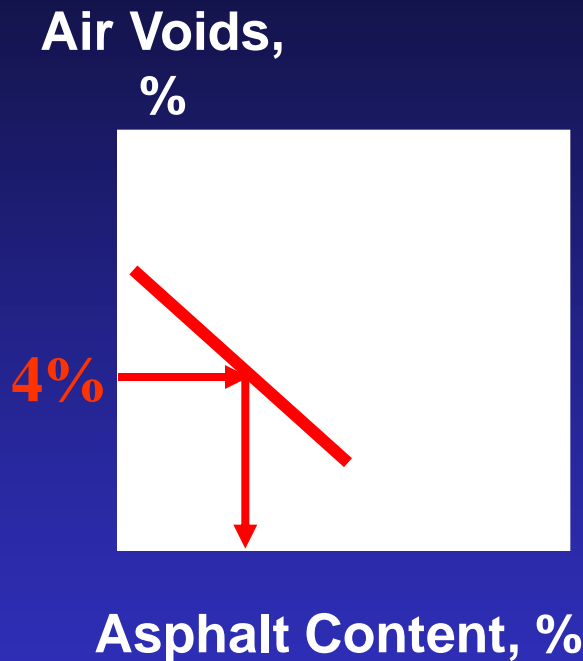
Asphalt Institute Procedure



Use target optimum asphalt content to check if these criteria are met

Marshall Design Use of Data

NAPA Procedure

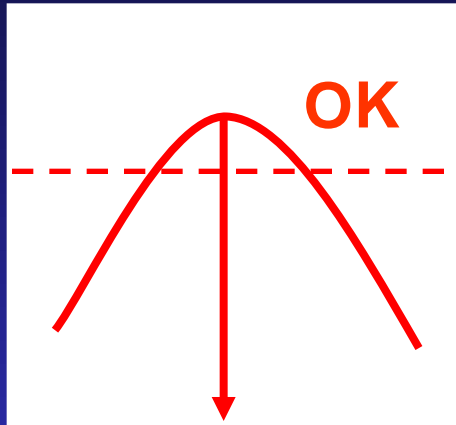


Target optimum asphalt content =
the asphalt content at 4% air voids

Marshall Design Use of Data

NAPA Procedure

Stability



Asphalt Content, %

The target stability is checked

Marshall Design Use of Data

NAPA Procedure

Flow

VMA, %

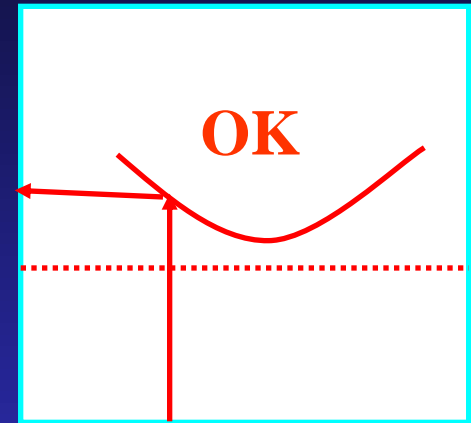
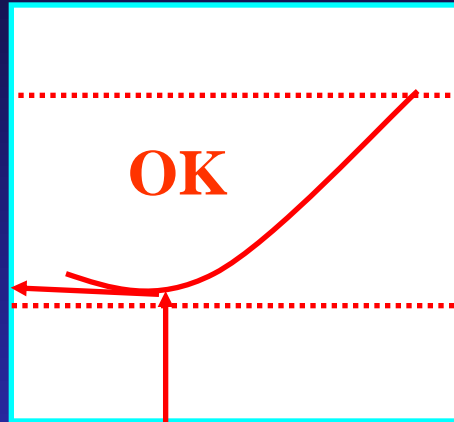
Upper limit

OK

OK

Minimum

Lower Limit



Asphalt Content, %

Asphalt Content, %

Use target optimum asphalt content to check
if these criteria are met

Marshall Design Method

- **Advantages**

- Attention on voids, strength, durability
- Inexpensive equipment.
- Easy to use in process control/acceptance.

- **Disadvantages**

- Impact method of compaction
- Does not consider shear strength
- Load perpendicular to compaction axis