ADVANTAGES OF CENTRIFUGALLY CAST BIMETALLIC ROLLS
WHAT IS VERTICAL CENTRIFUGAL CASTING

- IN VERTICAL CENTRIFUGAL CASTING PROCESS
  - A PERMANENT MOLD IS ROTATED ABOUT ITS VERTICAL AXIS
  - THE MOLD IS SPUN AT HIGH SPEEDS (USUALLY 50 TO 100 TIMES GRAVITY FORCE)
  - AS THE MOLTEN METAL IS POURED, THE MOLTEN METAL IS CENTRIFUGALLY THROWN TOWARDS THE INSIDE MOLD WALL
  - THE OUTSIDE OF THE MOLD IS COOLED BY WATER, THUS PROVIDING "DIRECTIONAL SOLIDIFICATION" FROM OUTSIDE TO INSIDE.
STATIC (SAND CASTING)

A pattern, metal delivery system (gates and risers) is constructed out of hardwood. Sand containing bonding material is packed around the pattern. Molten metal is poured into the cavity and the metal solidifies. The sand is removed through a shakeout process.

VERTICAL CENTRIFUGAL CASTING

- A permanent mold is rotated about its Vertical axis.
- The Mold is spun at high speeds (Usually 50 TO 100 times GRAVITY FORCE).
- The molten metal is poured. The molten metal is centrifugally thrown towards the inside mold wall.
- THE OUTSIDE OF THE MOLD IS WATER COOLED.
DIFFERENCES BETWEEN HOW METALS SOLIDIFY: CENTRIFUGAL CASTING VS STATIC (SAND) CASTING

STATIC (SAND) CASTING

- Metal start to solidify from the mold top and bottom, leading to centerline shrinkage in the casting.

CENTRIFUGAL CASTING

- Solidification starts as a thin layer at the outside diam.
- Builds layer by layer towards the hollow bore.
- Due to directional solidification, shrinkage voids move to the bore.
SHRINKAGE POROSITY COMPARISON

Casting Soundness Comparison

CENTRIFUGAL CASTING

NO SHRINKAGE

ARROWS SHOW SOLIDIFICATION DIRECTION

STATIC CASTING

AREA OF MIDWALL SHRINKAGE
FEEDING METAL : CENTRIFUGAL CASTING VS STATIC CASTING

CENTRIFUGAL CASTING
- As metal solidify, the solidification is fed by a huge surface area of high pressure molten metal.

RESULT
- Shrinkage voids and gas entrapment move towards bore and are eliminated in centrifugally cast rolls.

SAND CASTING
- As metal solidity, molten metal is fed through a complex network of narrow gates and risers.

RESULT
- Potential for shrinkage voids and gas holes in the casting.
GRAIN SIZE DIFFERENCE : CENTRIFUGAL CASTING Vs SAND CASTING

CENTRIFUGAL CASTING
- SINCE CENTRIFUGAL CASTING MOLD IS STEEL OR GRAPHITE, THEY PROVIDE HIGHER HEAT EXTRACTION (DUE TO HIGHER CONDUCTIVITY) THAN SAND
- THE MOLD IS WATER COOLED, PROVIDING ADDITIONAL COOLING (CHILL) TO THE OUTSIDE DIAMETER (WORKING SURFACE OF THE ROLL)
- RESULT: MUCH FINER GRAIN STRUCTURE

STATIC CASTING
- THE SAND AND OTHER BINDER MATERIAL USED ARE POOR CONDUCTOR OF HEAT.
- DUE TO GATING AND RISER NETWORK, A HIGHER POUR TEMP IS REQUIRED
- RESULT: COARSE GRAIN STRUCTURE
CENTRIFUGAL CASTING “G” FORCE

WHAT IS G- FORCE

- JUST AS THE AMUSEMENT PARK RIDE FORCES RIDERS UP ITS WALLS, IN CENTRIFUGAL CASTING MACHINE, THE METAL IS PUSHED OUTWARD UNDER FORCES MANY TIMES THAT OF GRAVITY, CALLED “G- FORCE”

- THE HIGH G-FORCES (50-100 TIMES THE GRAVITY) APPLIED TO THE MOLTEN METAL IN THE SPINNING ALLOWS, LESS DENSE MATERIALS LIKE SLAG, IMPURITIES, GAS TO “FLOAT” TO THE I.D. WHERE IT IS SUBSEQUENTLY REMOVED BY MACHINING.

- METAL SOLIDIFY UNDER PRESSURE, FROM THE O.D. TO THE I.D., LEAVING A DEFECT-FREE STRUCTURE WITHOUT CAVITIES OR GAS POCKETS
DEFECTS UNIQUE TO STATIC SAND CASTING

- Metal solidified before filling the mold cavity
- Two Portions of metal flow together from different directions, but there is lack of fusion
- Internal void caused by solidification shrinkage

CENTRIFUGALLY CAST ROLLS WILL HAVE NO SUCH DEFECTS
DEFECTS UNIQUE TO STATIC SAND CASTING

Metal Penetrated in Sand mold or core

Gas holes slightly below the surface of the casting

A step in the casting at the parting line due to shifted cope and drag

CENTRIFUGALLY CAST ROLLS WILL HAVE NONE OF THESE DEFECTS
CENTRIFUGALLY CAST ROLLS - ADVANTAGES SUMMARY

- Higher mechanical properties due to fine grain structures
- Building a metal component in the centrifugal method is like building a house; you start with the foundation and go up.
- Of course, the foundation of a house is built not with irregularly shaped stones but various identically shaped blocks. The grain structure of a centrifugal component has the same traits.
- Since metal solidifies under pressure, a dense metal structure is produced.
- Free of impurites and gas holes due to high G-force during casting.
- Free of shrinkage voids due to directional solidification.
- Since no sand, gates or risers are required, defects unique to static sand casting (such as misrun, cold shut, surface pin holes, sand defects, etc) is virtually eliminated.
WHAT IS A BIMETALLIC SLEEVE

- A BIMETALLIC SLEEVE HAS A HARDER SHELL (OUTER) MATERIAL AND A SOFTER CORE (INNER) MATERIAL.
- REASON
- STEEL MILL ROLLS NEED TO BE “HIGH WEAR RESISTANT” AND AT THE SAME TIME NEED BE IMPACT RESISTANT TO AVOID BREAKAGE
- THIS IS POSSIBLE WITH BIMETALLIC SLEEVES BY CASTING OUTER LAYER WITH HIGH WEAR RESISTANT ALLOY AND INNER LAYER RELATIVELY HIGH IMPACT RESISTANT ALLOY
A COMPOSITE BIMETALLIC SLEEVE ROLL HAS A “BIMETALLIC SLEEVE” SHRINK FITTED ON TO AN ARBOR.
HARDNESS PROFILE OF BIMETALLIC SLEEVE & CONVENTIONAL MONOBLOC
ADVANTAGES OF CENTRIFUGALLY CAST BIMETALLIC SLEEVE COMPOSITE ROLLS

“WEAR RESISTANCE AND BREAKAGE RESISTANCE ARE CONFLICTING REQUIREMENTS”

- WITH COMPOSITE BIMETALLIC SLEEVE ROLLS, IT IS POSSIBLE TO IMPROVE BOTH WEAR AND BREAKAGE RESISTANCE
- BY CHOOSING A CENTRIFUGALLY CAST BIMETALLIC SLEEVE WITH HIGHER SHELL HARDNESS AND LOWER CORE HARDNESS AND CHOOSING HIGH TOUGHNESS ARBOR.
- CENTRIFUALLY CAST BIMETALLIC SLEEVES PROVIDE FINE GRAIN, METALLURGICALLY SUPERIOR MECHANICAL PROPERTIES
- THEREFORE CENTRIFUGALLY CAST BIMETALLIC SLEEVE/FORGED ARBOR COMBINATION PROVIDE SUPERIOR WEAR RESISTANCE WITH LESS CHANCES FOR BREAKAGE.