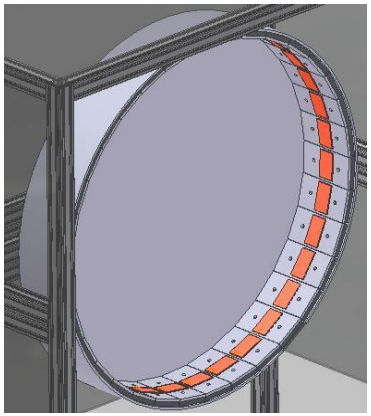
Wear resistant materials

Oscar Gong , M.Sc.
Development Engineer
SSAB APAC

Investigation of wear resistance

- The testing apparatus
  - Cylindrical drum
  - Capacity: 34 samples
  - Adjustable RPM
  - Two types of lid
    - Polyurethane
    - Steel



Steel grades

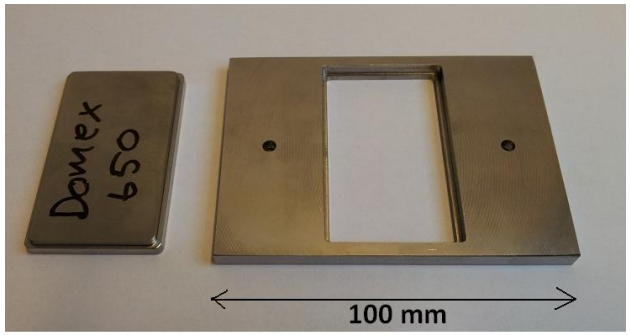
Steel grade	Hardness [HV]
S235	126
Hardox 400	408
Hardox 450	486
Hardox 500	518
Hardox 550	581
Hardox 600	616
Hardox Extreme	683
CCO overlay plate	750 (average)

Test 1 Sliding wear
Abrasives and Test Process

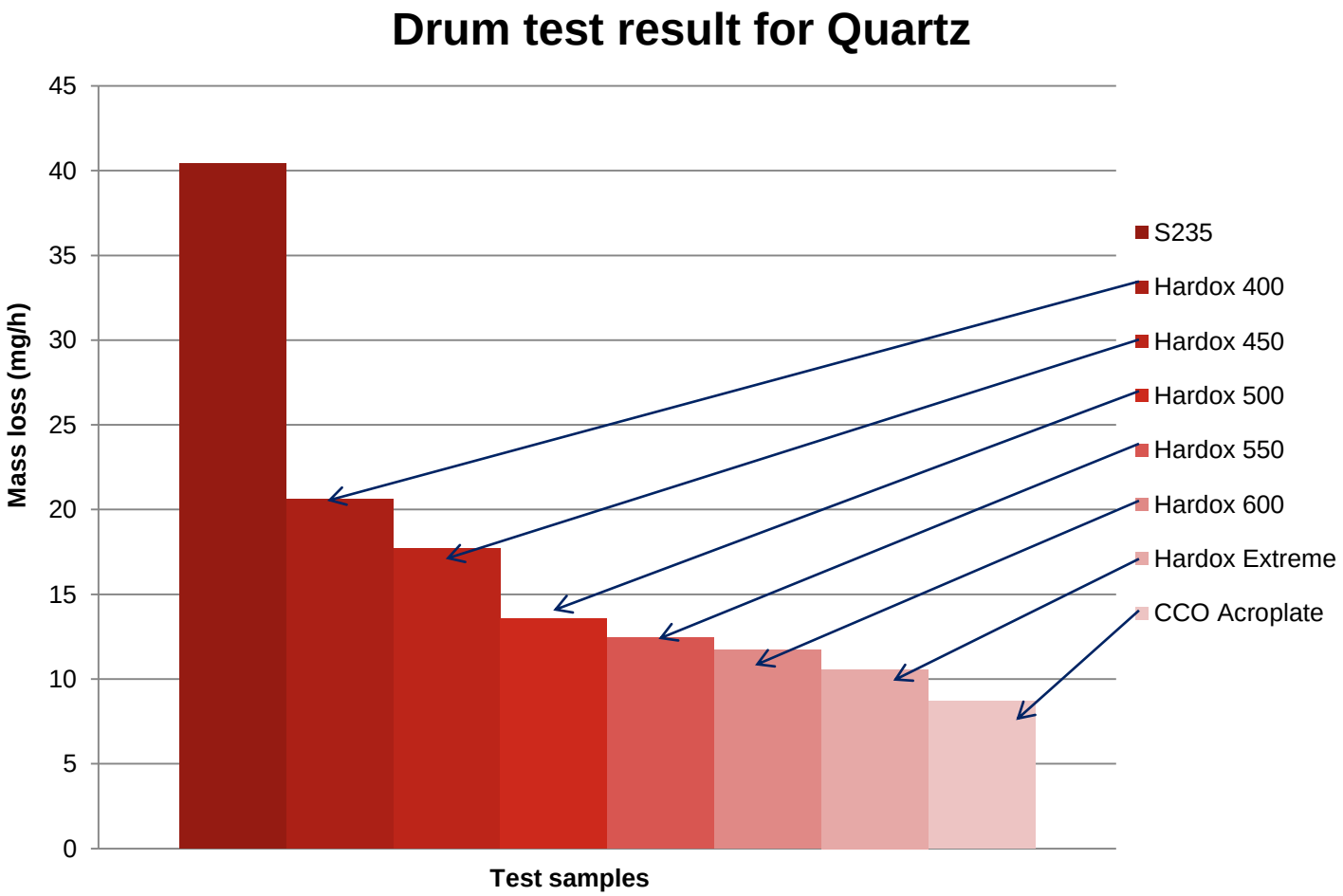
- Quartz
  - 16-32 mm
  - Sharp edges
  - Test with addition of 2L water
- Test process
  - 92 hours/test
  - Changing abrasive and water 2 times/day
  - Test with 10kg of abrasive mixed with 2L of water
  - Rotation speed: 30rpm

Samples

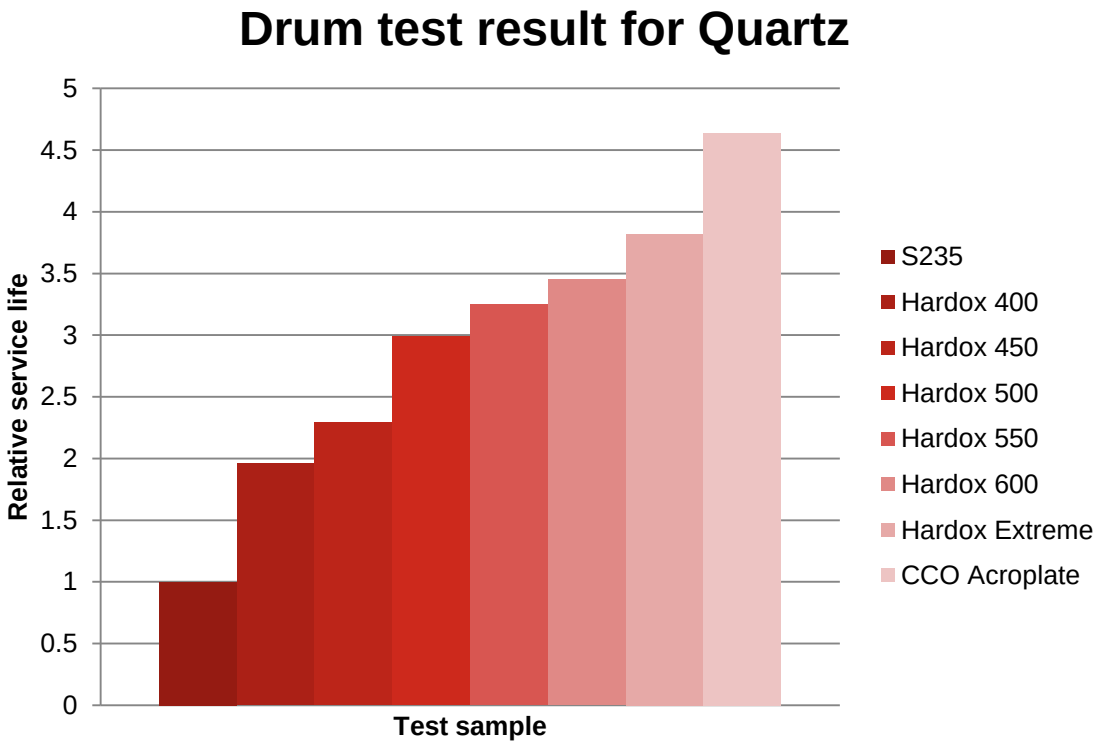
- Samples
  - 62x38 / 60x35 [mm]
  - Various thicknesses (3-8 mm)
- Holders
  - 100x70 [mm]
  - Toolox 44
  - Various thicknesses (6-8mm)



Test result - Sliding wear



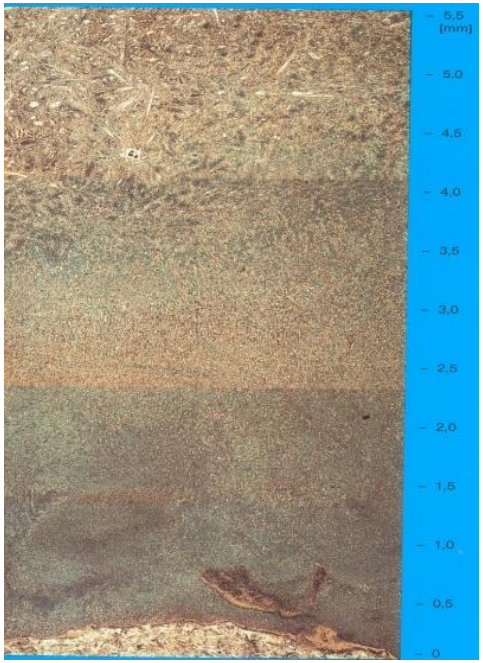
Relative service life

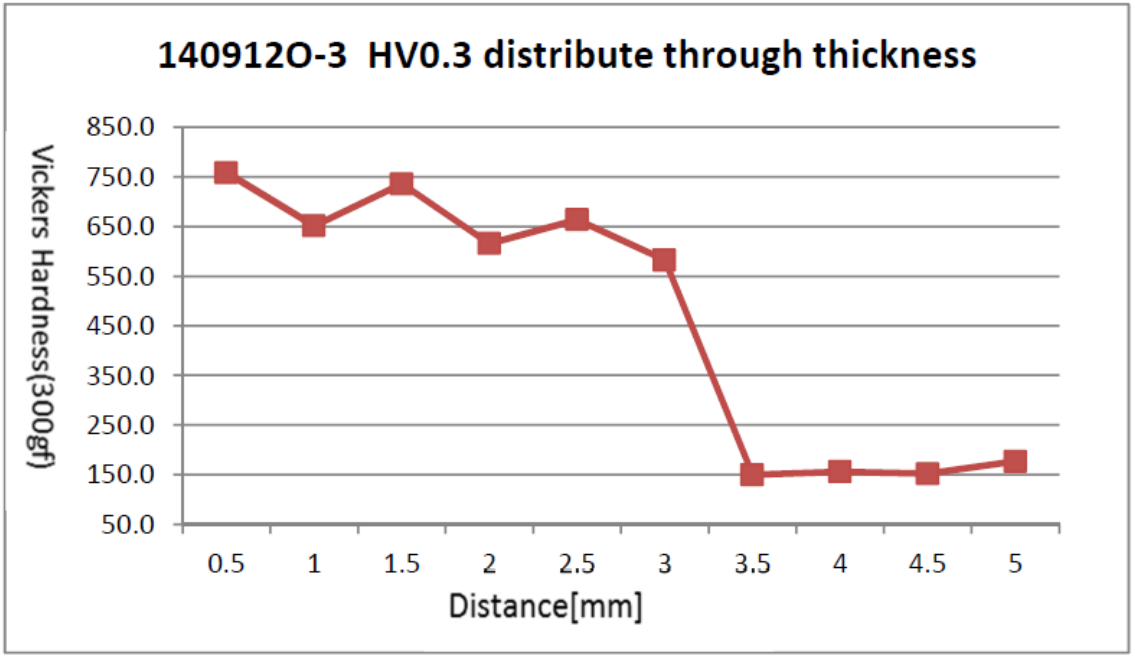


- Hardox 600 gives a 3.45 times higher service life than mild steel
- CCO overlay plate has 33% longer service life than Hardox 600
- But…

SSAB

Hardness distribution of overlay plate





Hardness distribute through thickness of Hardfacing material6+4

- Dilution can exist in the hard-facing layer, which leads to a drop in hardness;
- For a typical 10mm (6+4) overlay plate, only approximately 3mm is contributing and giving 33% better performance than Hardox 600;
- Through calculation,10mm Hardox 600 can give over 45% longer service life than 10mm overlay plate;

Hardness distribution of Hardox 600

Equipment model: 402MVD Test temperature: 20.7℃

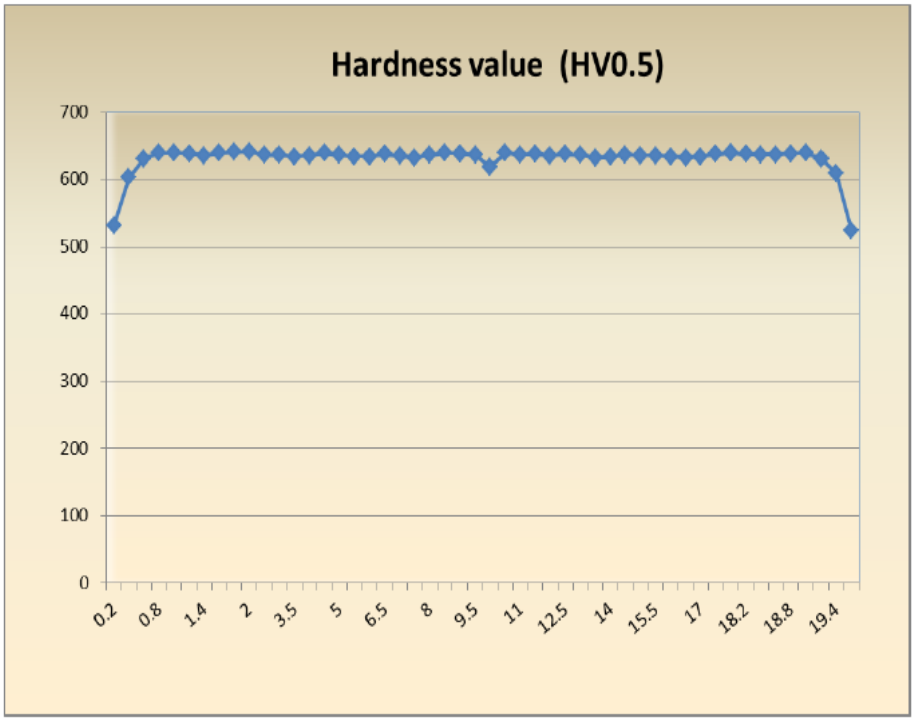


Fig. 1 hardness curve of Hardox 600 20mm hardness distribute through thicknesss

- Hardox 600 can give a much even hardness distribution throughout the thickness direction;
- Can give a even wear rate during the entire service life;
- Make it possible to predict the service life and schedule the maintenance accordingly;
- Quality continuity will guarantee a repeatable and predictable wear resistant behavior;

SSAB

Test 2 Mid Impact wear
Abrasives and Test Process

- Granite
  - 16-25 mm
  - Avg. 11,06 g
  - Sharp edges
  - Chemical analysis (SGU)

Type 1

Mineral	Vol %	Hardness [HV]
Quartzite	33	1070
Plagioclase	33	725/940
Kali-feldspar	31	725
Chlorite	3	20/30

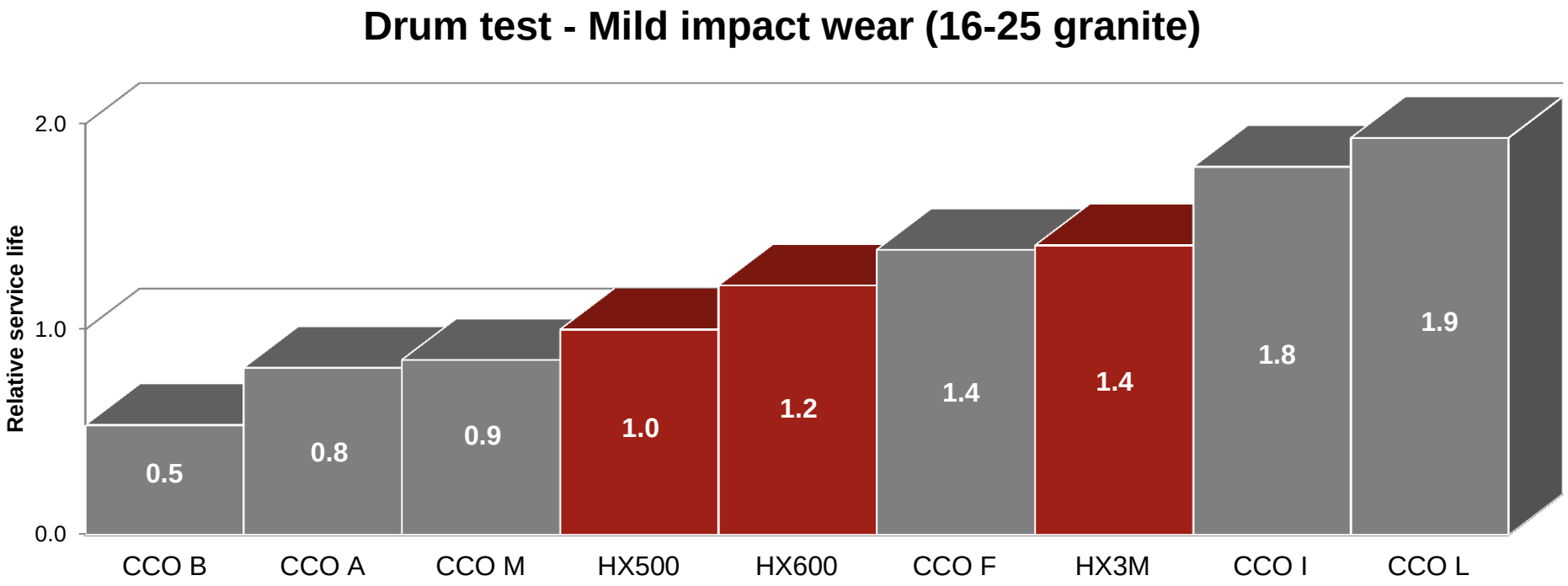
Type 2

Mineral	Vol %	Hardness [HV]
Amphibole	36	360/725
Plagioclase	32	725/940
Kali-feldspar	24	725
Chlorite	8	20/30

Type 3

Mineral	Vol %	Hardness [HV]
Quartzite	40	1070
Biotite	3	30/60
Plagioclase	35	725/940
Kali-feldspar	17	725
Chlorite	5	20/30

Result – Mid Impact Wear



- In general, overlay plate is behaviouring worse in impact wear condition comparing to sliding wear;
- The behavior of overlay plates differ a lot with different manufactories as well as the quality (CCO I and L are made by SSAB America);
- In heavy impact situation, overlay plate will not perform as good as Hardox 500 and above;

Conclusions

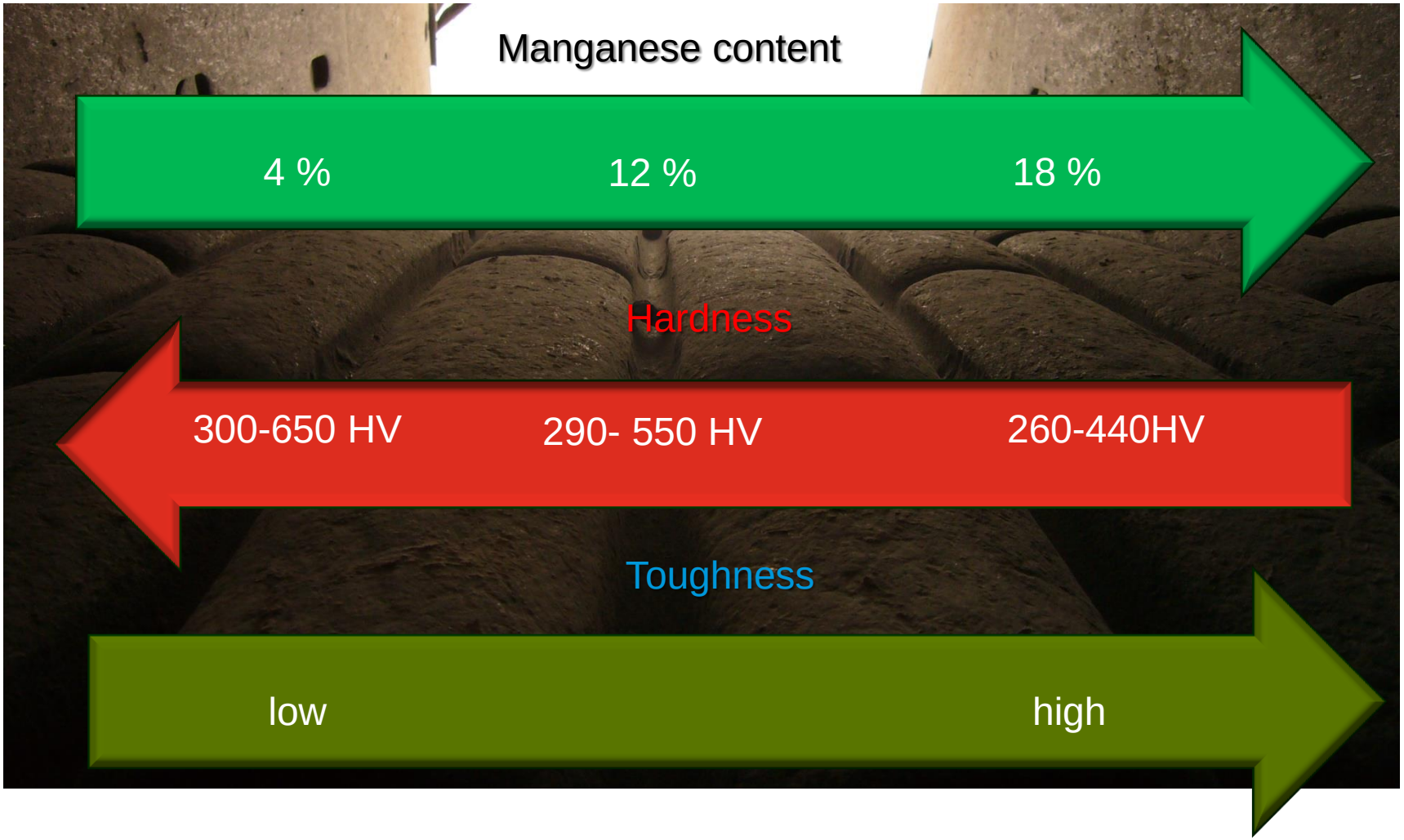
For Quartz material (16-32mm) as abrasive, CCO overlay plate gives 33% longer service life comparing to Hardox 600 in sliding wear condition;

Due to dilution and drop in hardness of overlay plate, a 10mm (6+4) overlay plate may have a 45% shorter service life comparing to 10mm Hardox 600;

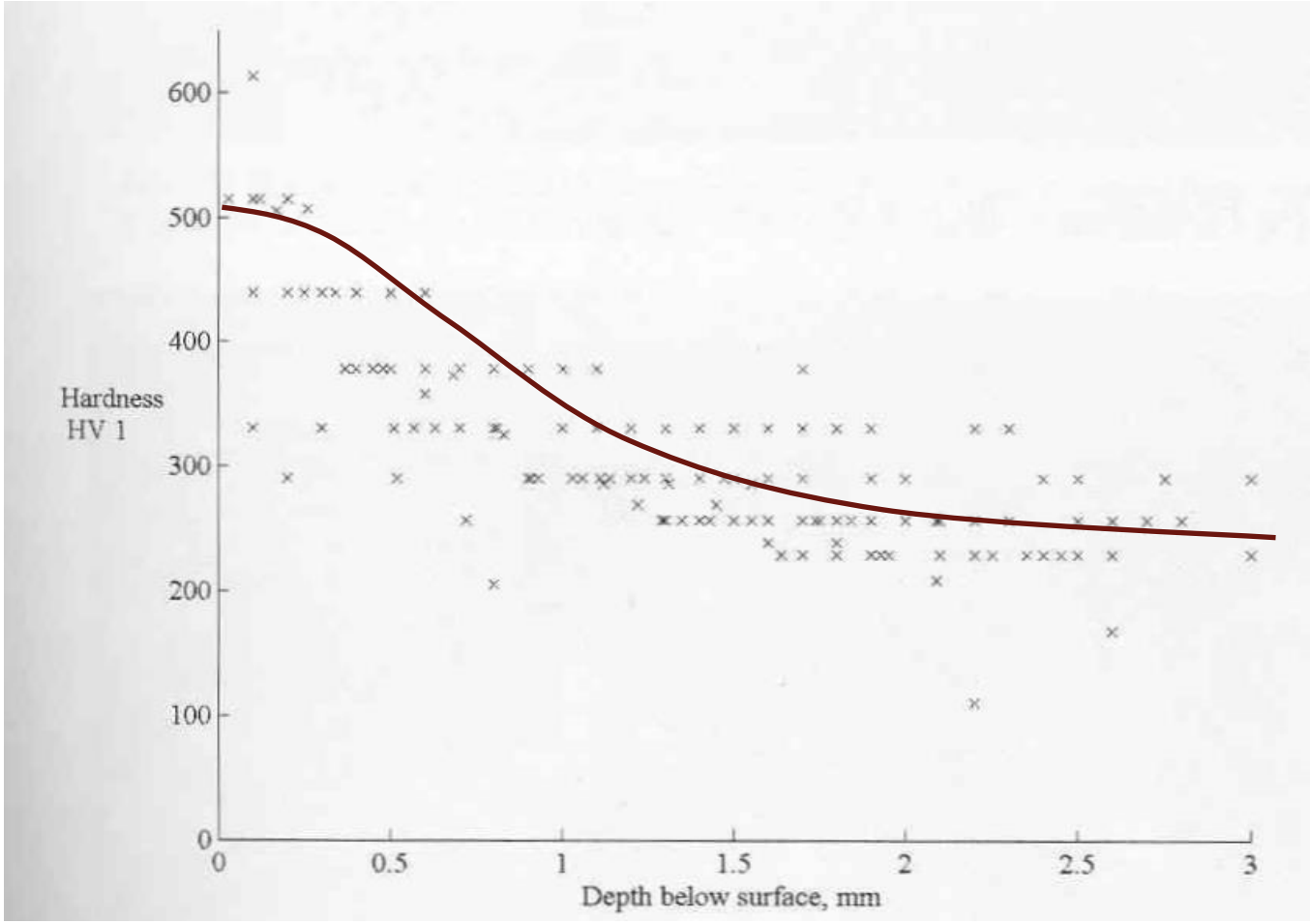
For the mid impact wear test using Granite (13-25mm), the behavior of overlay plate differ a lot with different suppliers, in general they are behavioring worse than Hardox 600;

With proper handling, Hardox 600 is believed to be a sufficient replacement of overlay plate and a better service life can be expected;

Manganese steel

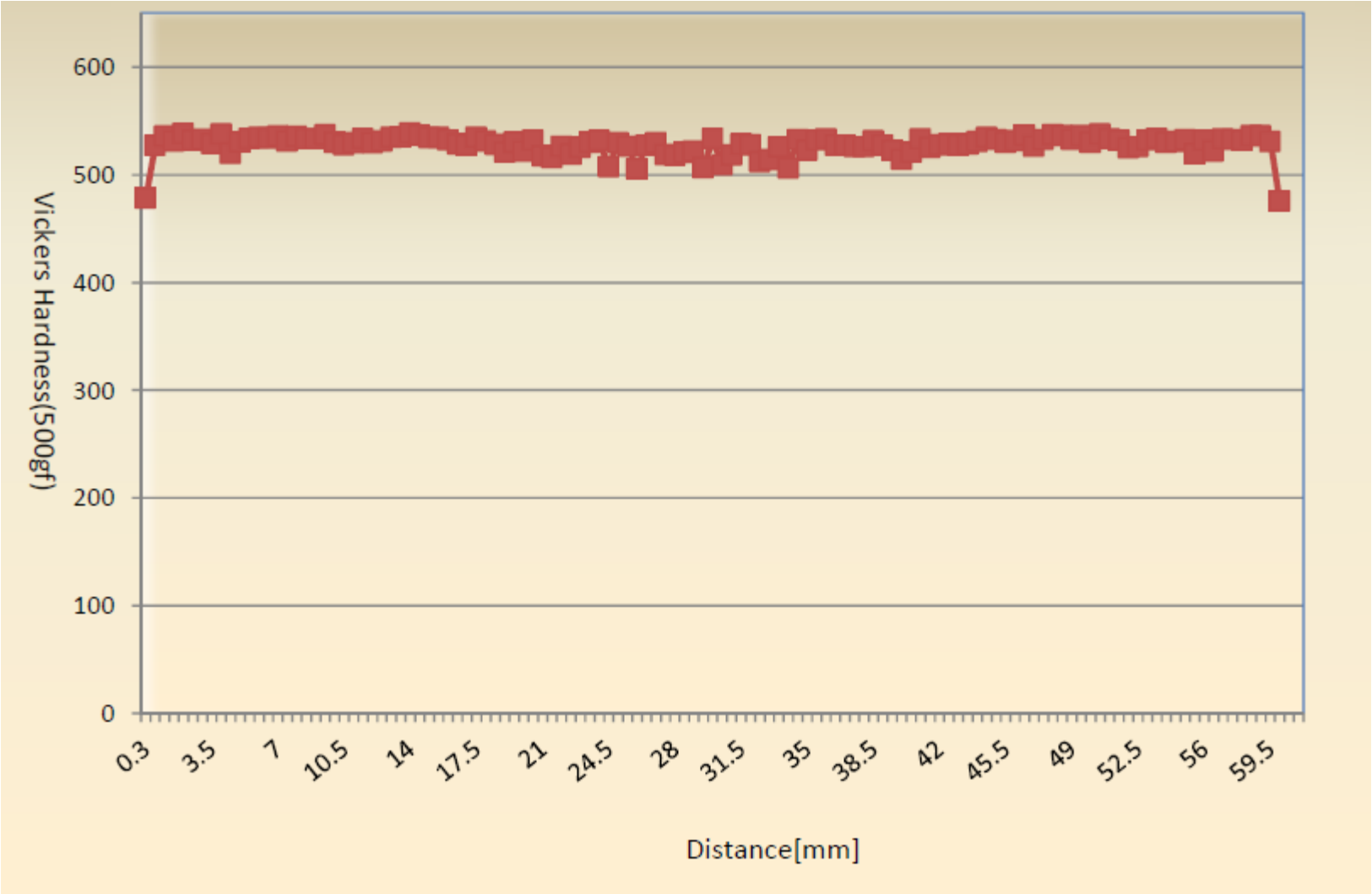


12% Mn-steel usually used as hammer



- Due to work hardening effect, the surface layer can reach over 500HV hardness, but only less than 0.2mm;
- Still very tough in the subsurface;

Hardness distribution of 60mm Hardox 500



SSAB

Mn steel and Hardox 500

- Depending on the Mn content, the surface layer of Mn steel after work hardening can reach 700-500HV, to the thickness of 0.2mm;
- Underneath the hard layer, the matrix remain the toughness and can absorb some impact energy during working;
- For abrasives with high hardness and sharpness, this layer will be penetrated easily and loss the effect;
- For the sliding wear, Mn stell will not be work hardened and will perform just as mild steel;
- Hardox 500 has an even hardness distribution throughout the thickness level, guaranteed a stable and predictable service life;
- High hardness combined with high toughness secured Hardox 500 to have an outstanding behavior under both sliding and impact wear conditions;

Hammer in impact crusher

Introduction:

Used for lime stone crushing in Zibo, Shandong Province;

Started on 18th May 2013;

Made by Hardox 500 in 80mm thickness;

Current situation:

- The total service life is around 6 months;
- The previous using material is Mn and high alloy castings with service life of only 15 days to 1.5months;
- Very unstable service life of previous using material due to casting quality;

Xinkaiyuan Crushing plant

Introduction:
Started on 4th Feb, 2013;
Hardox 500 in 15mm is used as liner plate in feeding plant. Abrasive material is Basalt with size between 50-400mm, the amount that passed through liner plate everyday is 8000 tons;

- Did the first and second wear measurement, got around 6mm wear amount at most severe area;
- The service life for previous using 25mm 16Mn is 6 months while for 15mm Hardox 500 the estimated service life can be 17 months;
- The average wear rate for 16Mn is 4 times higher than Hardox 500;

Hardox 500 in 15mm thickness


SSAB
Thank you!