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Influence of the agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

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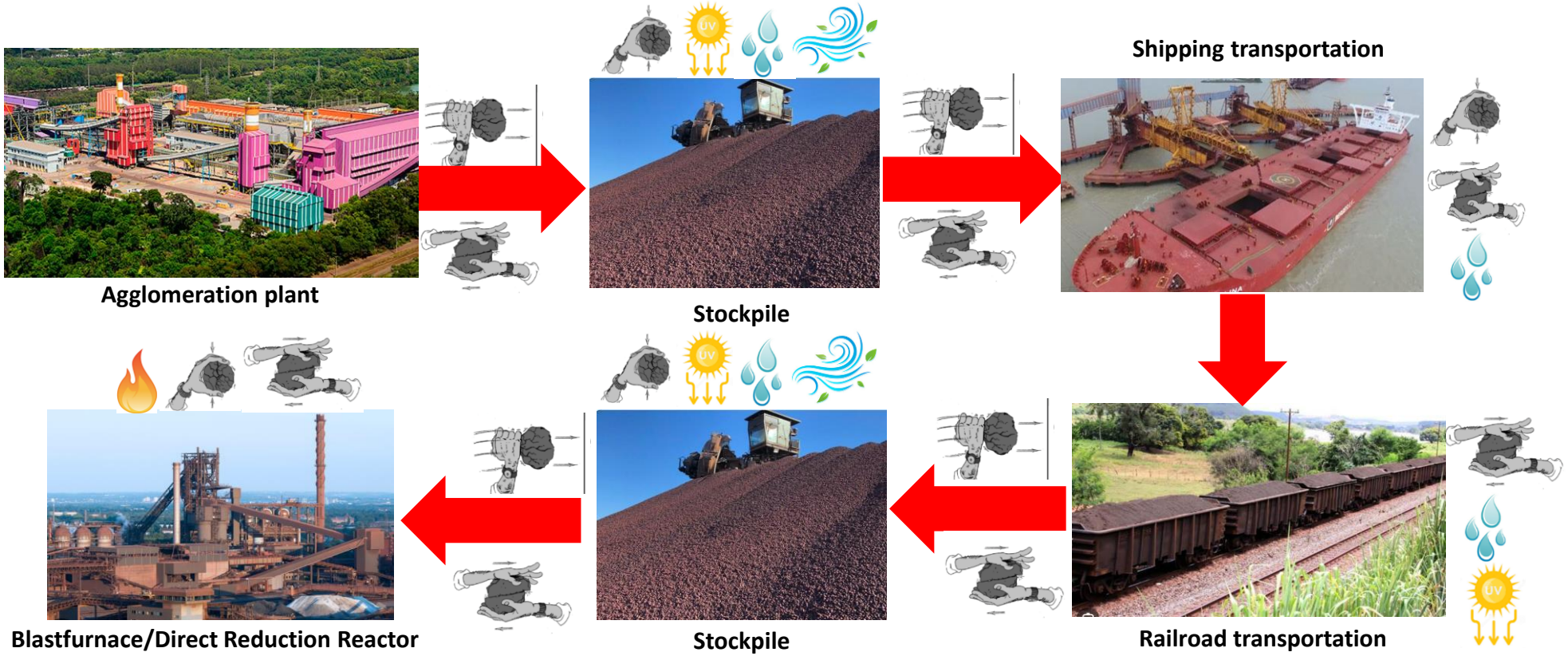
The 5th SYMPOSIUM

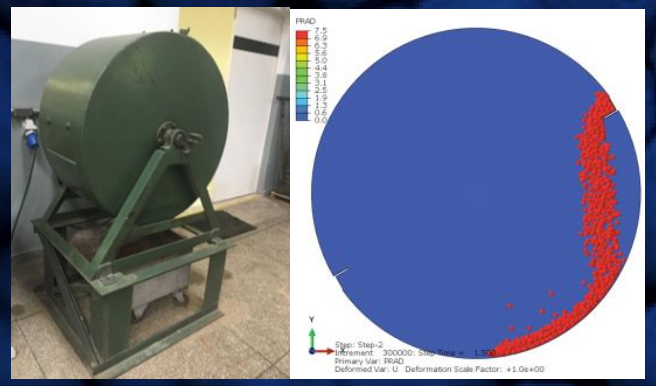
Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Different burden materials, with different size and shape, which may be used in blast furnace and direct reduction reactors in the steelmaking industry.

Whatever application of the agglomerate products, it needs to withstand mechanical stress promoted by handling, transport, and loading when stored in pile or during the reduction process

Mechanical specifications of the agglomerated products are defined according to the intensity of these operations.



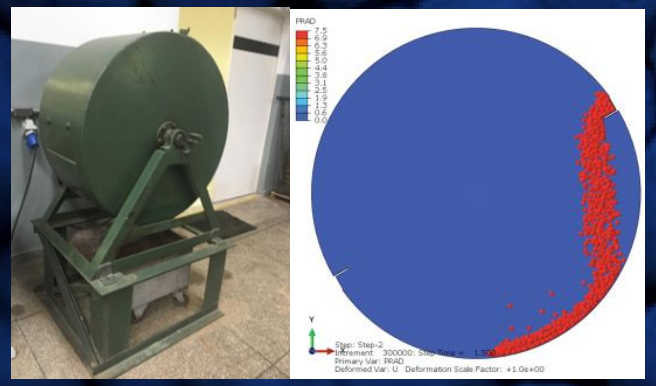


Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Breakage mechanism are evaluated by standardized tests elaborated by national and international technical associations:

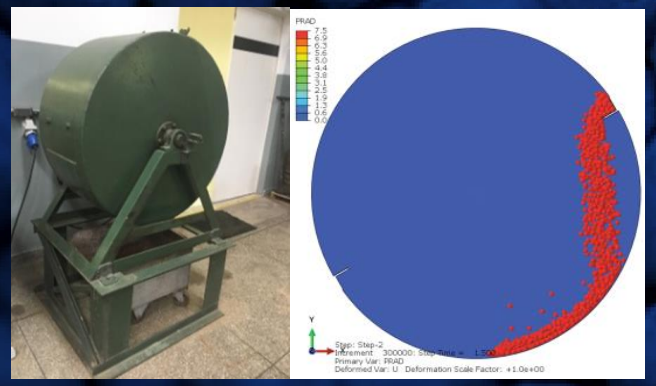
- Cold compression strength (ISO 4700)
- Abrasion + impact - tumbler and abrasion index (ISO 3271)
- Impact - drop test (JIS M8711)

Such norms, which are fundamental to evaluate the materials and its use in the industry, were established for sinter, pellets and lump ore, but not to briquette!



Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

- There is some references have been working on this theme.
- Bizhanov and Zagainov (2021) evaluated the compression and impact + abrasion (tumbling test) of pellets and extruded briquettes by Finite Element Method simulation.
- The difference between the aforementioned reference and our research is that we will evaluate the difference between pellets and briquettes obtained from a roller briquette machine.
- In addition, we will base our simulation on experimental data, that is, we will produce the same mixtures to pelletizing and roller briquetting.



Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

- The objective of the research is to **develop a methodology for comparing the cold compression strength of briquettes and pellets taking into account the benchmark evaluations.**
- This presentation is focused on the development of a method to evaluate the compression of briquettes obtained from roller machine.
- Here are present some ideas that will be evaluated in the next stages of research.

Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

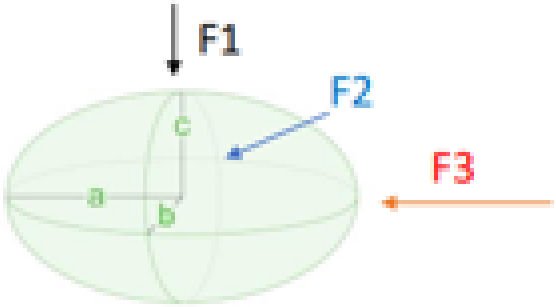
Briquette issue:

- Briquette shape is not spherical like pellets, they are pillow or ellipsoid shaped:

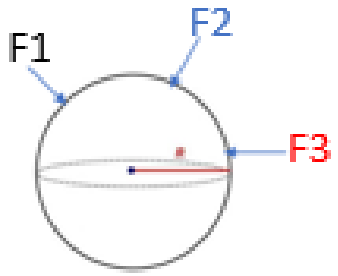
Ellipsoid briquettes

Pillow briquettes

Briquettes also have burrs and imperfections!



PELLET



pellet:

- **area 1 =area 2= area 3**
- **force 1 = force 2 = force 3**
- **strength 1 = strength 2 = strength 3**
- **strength is the same in all direction**

$$Strength: \frac{Maximum\ force}{Area\ (\pi\ x\ r^2)}$$

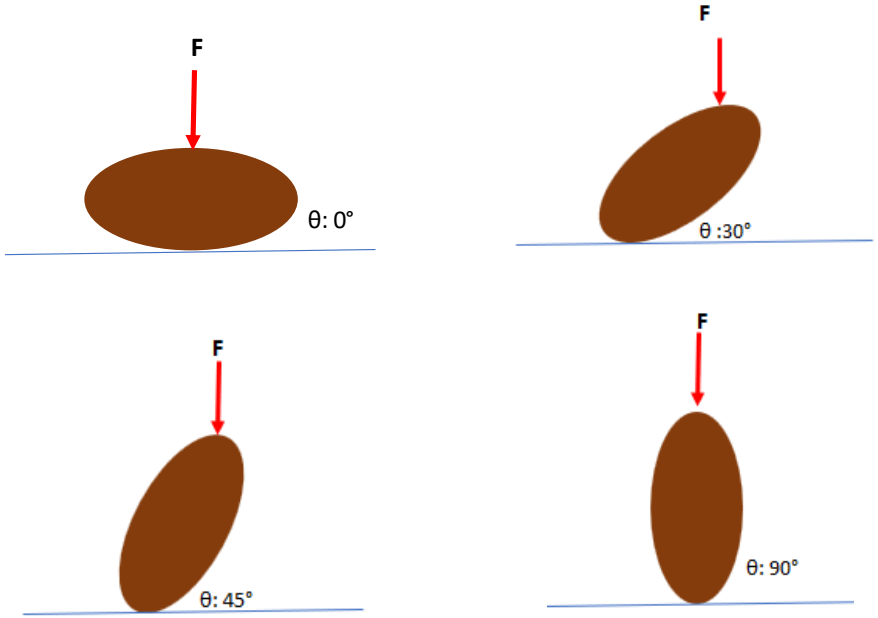
briquette:

- **area 1 ≠ area 2 ≠ area 3**
- **force 1 = force 2 = force 3 ??**
- **strength 1 ≠ strength 2 ≠ strength 3**
- **strength is not the same in all direction**

Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Briquette issue:

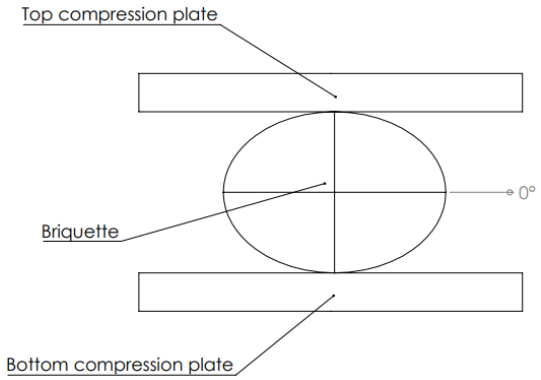
- In stockpiles or bed (Blastfurnace or Direct reduction reactor), briquettes are positioned in different directions:



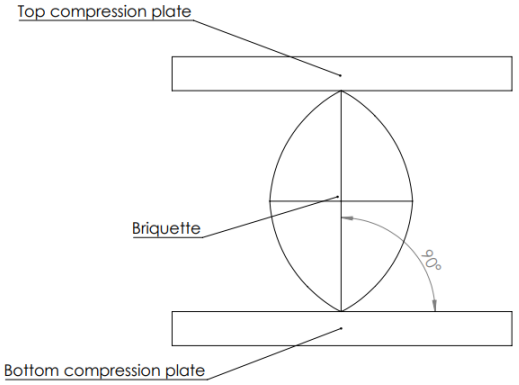
Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Materials and Methods:

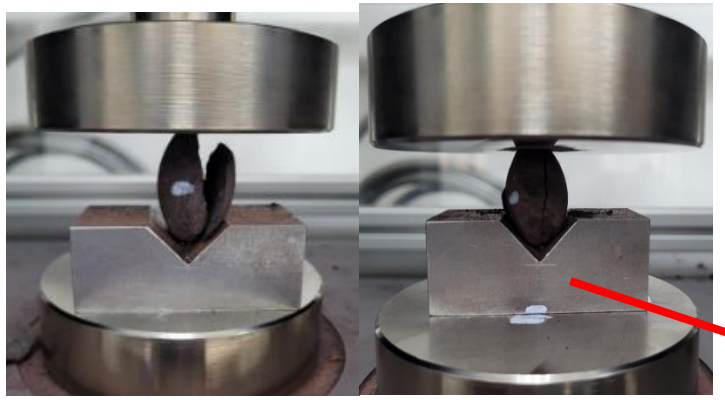
- Obtaining sample of iron ore ellipsoidal briquettes from pilot runs
- Physical characterization of briquettes in different positions (50 briquettes/position):

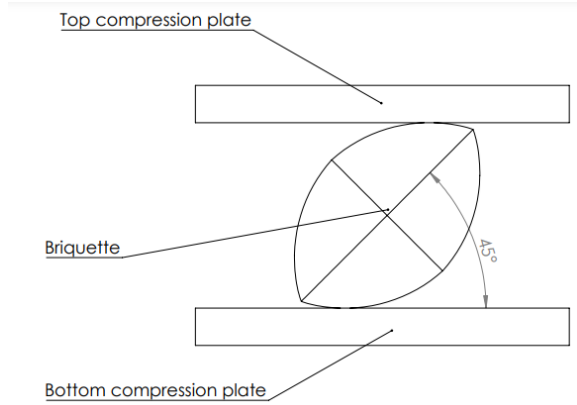


0° with horizontal plane (conventional method)

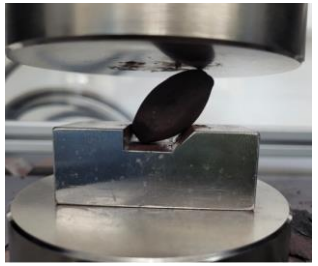


90° with horizontal plane - longer length and 90° horizontal plane - shorter length





45° with horizontal plane - longer length



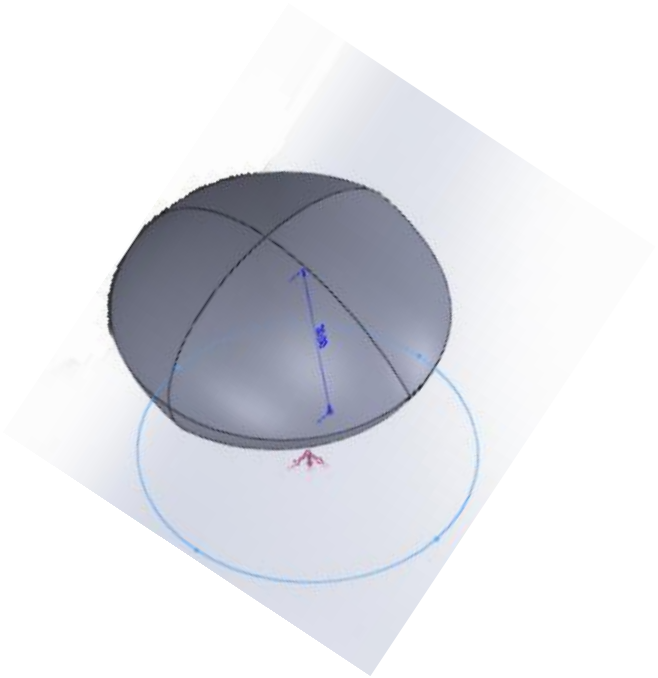
The support was made steel SAE 1020 to avoid deformation

Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

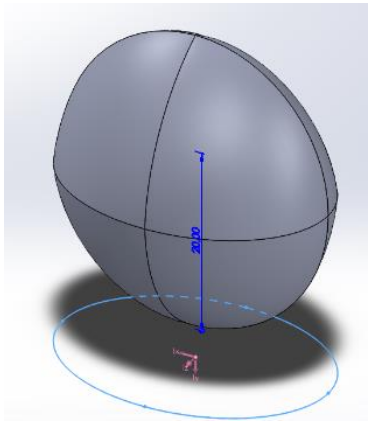
Materials and Methods:

- Briquette strength was calculated by ratio between force and projected area, expressed in terms of MPa:

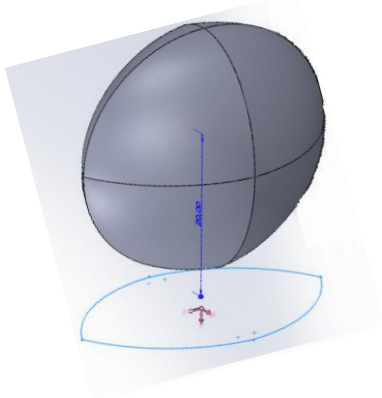
0° with horizontal plane (conventional method)



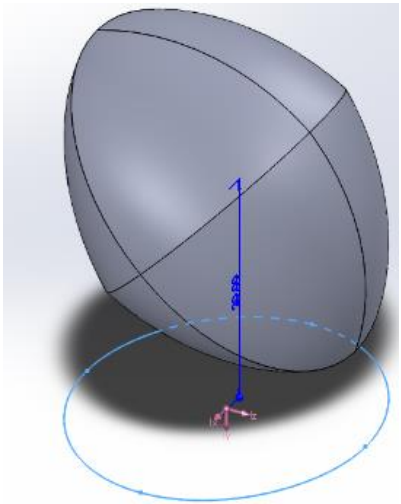
90° with horizontal plane - longer length



90° with horizontal plane - shorter length

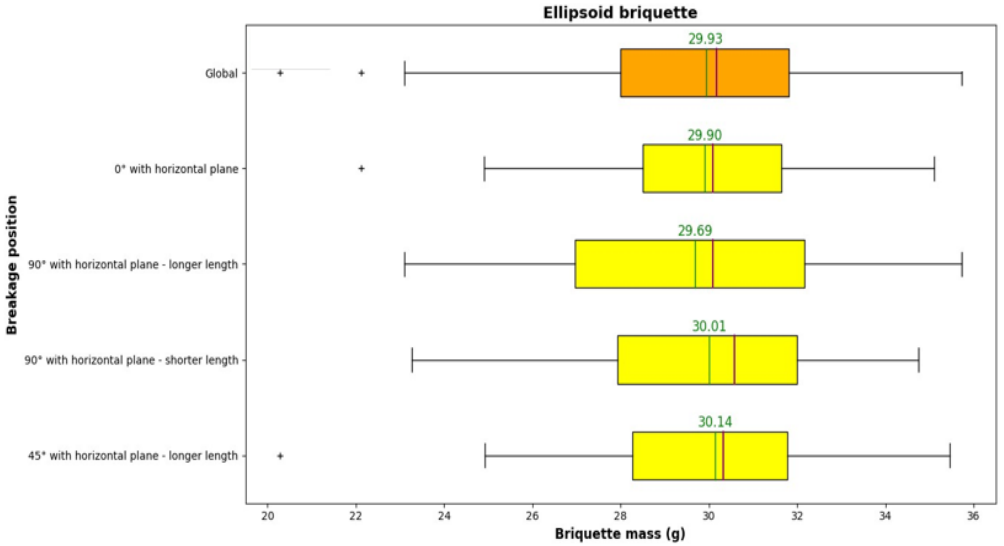


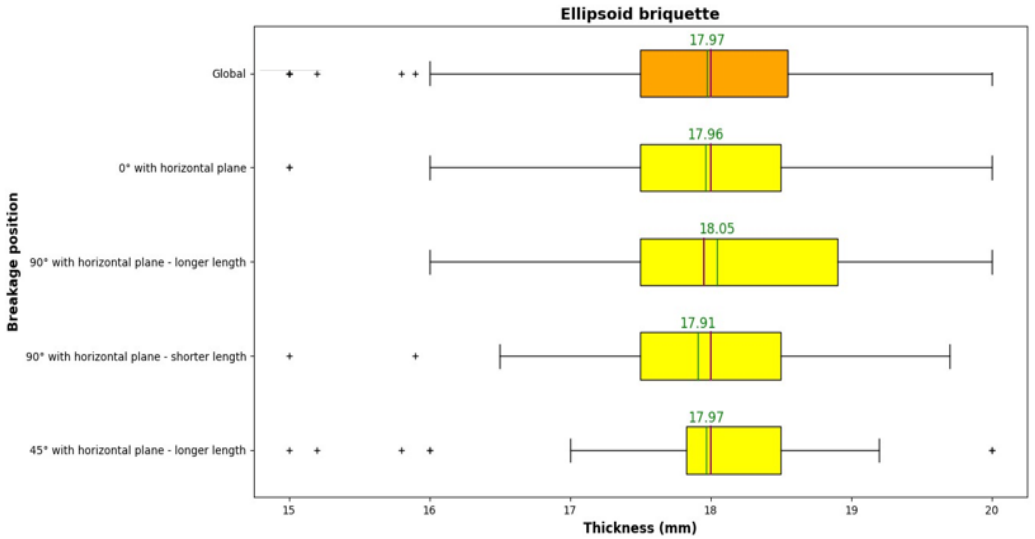
45° with horizontal plane - longer length

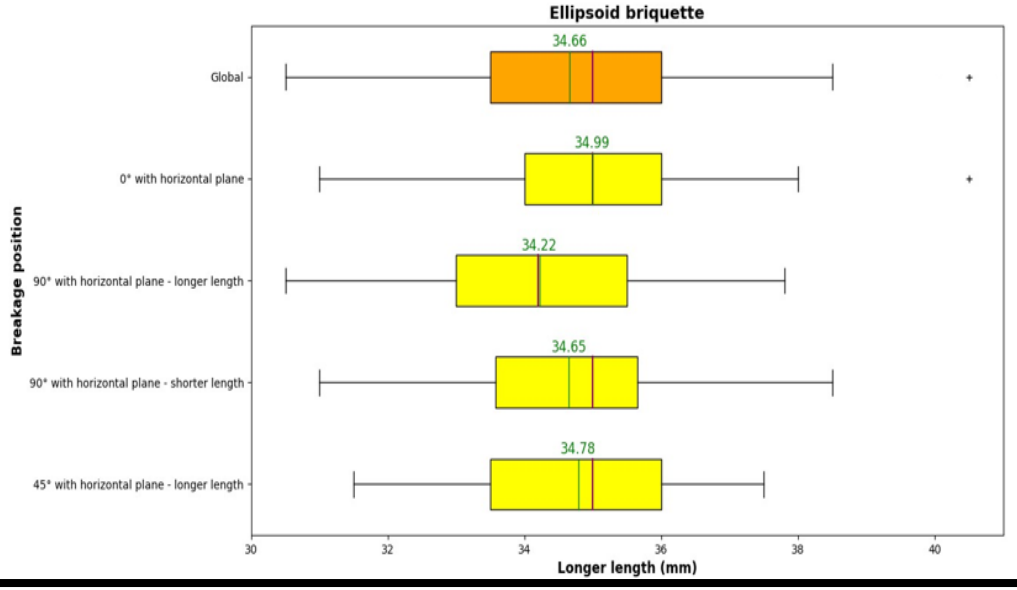


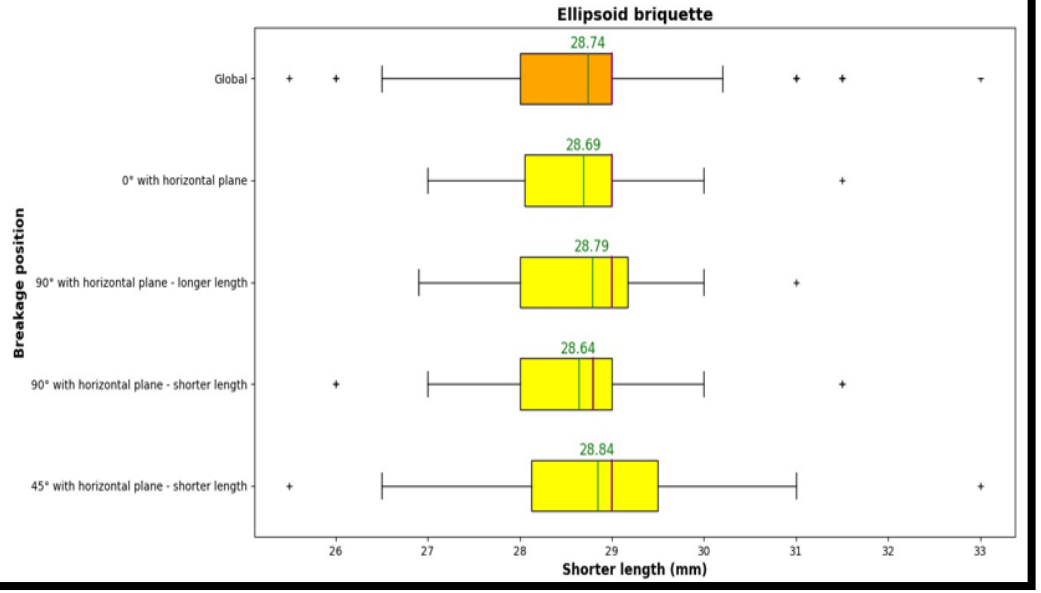
Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Results – mass and dimensions of evaluated briquettes:



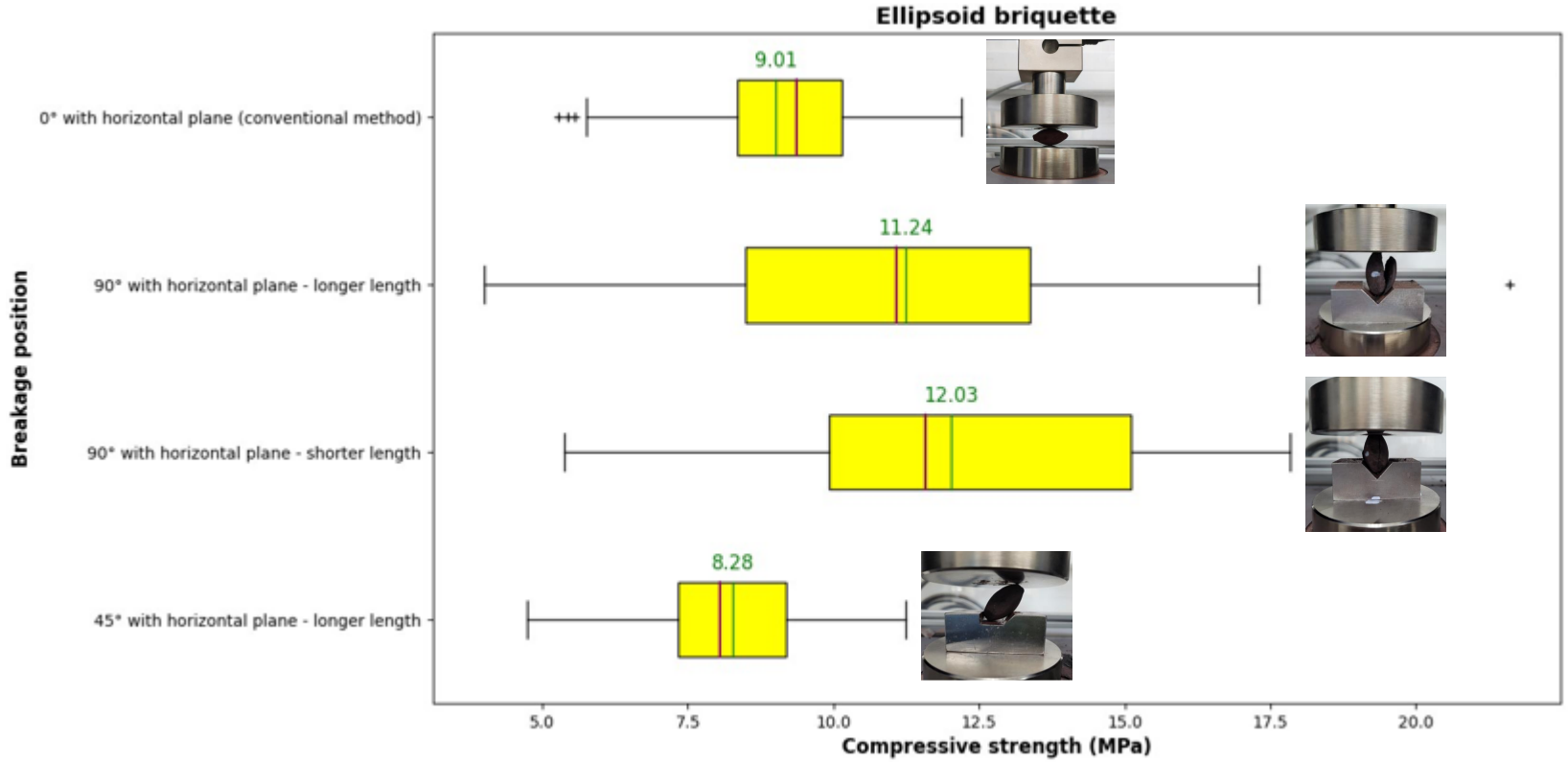






Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Results – compressive strength of evaluated briquettes:

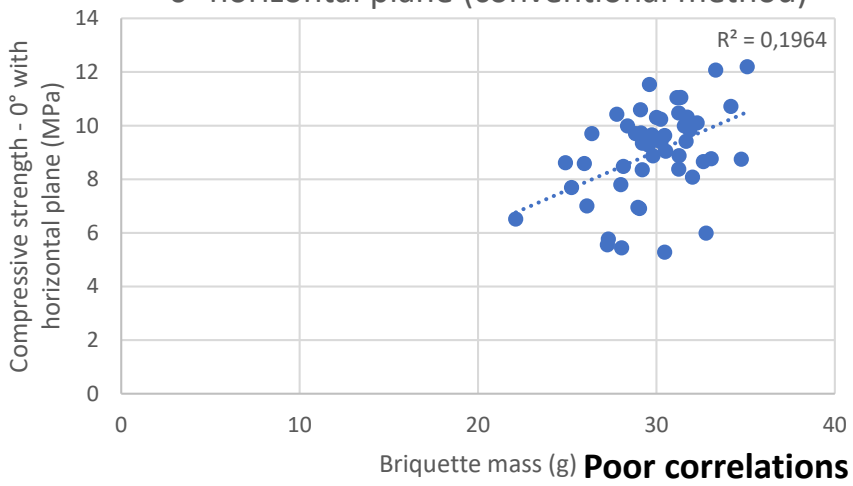


Breakage position	CCS relative variation in relation to CSS obtained in 0 ° horizontal plane (conventional method)
90° with horizontal plane - longer length	24,7 %
90° with horizontal plane - shorter length	33,4 %
45° with horizontal plane - longer length	-8,2 %

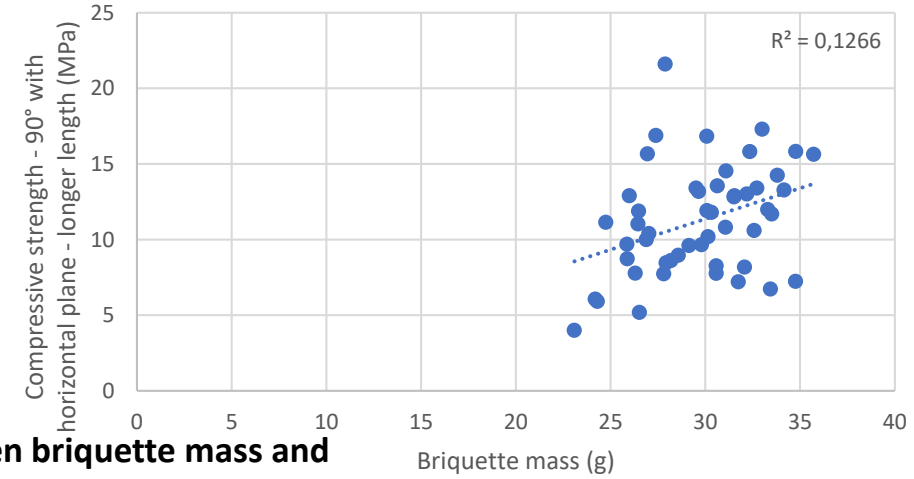
Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Results – evaluation of possible correlations:

0° horizontal plane (conventional method)

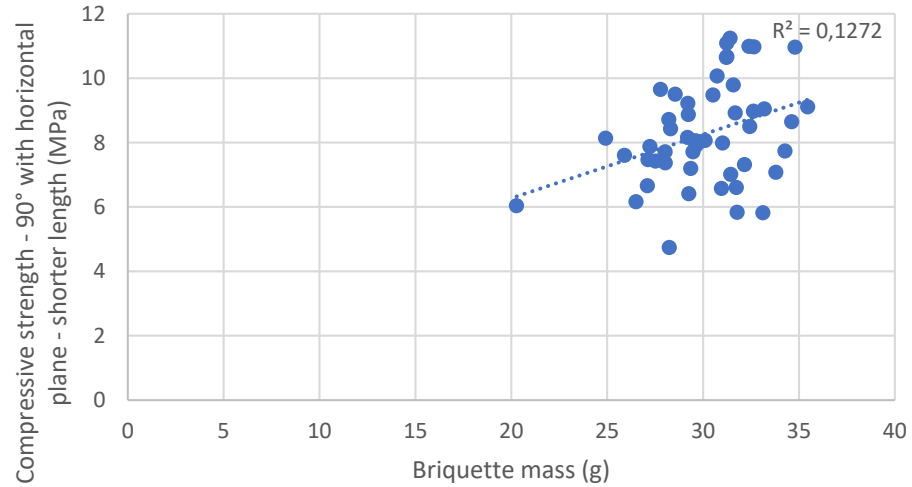


90° horizontal plane - longer length

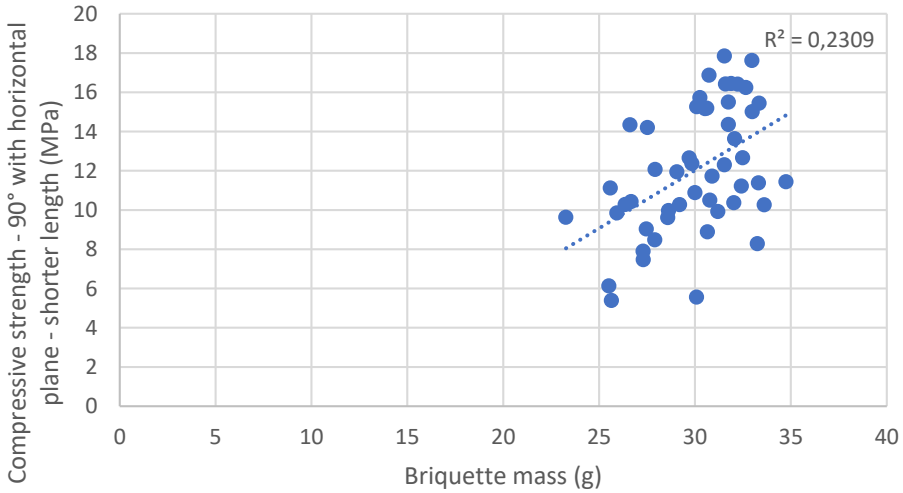


Poor correlations between briquette mass and compressive strength in different positions!

45° horizontal plane - longer length



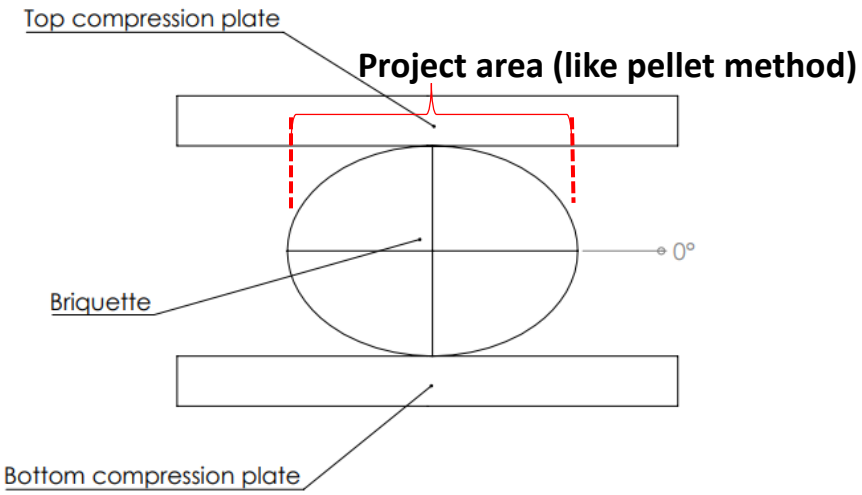
90° horizontal plane - shorter length

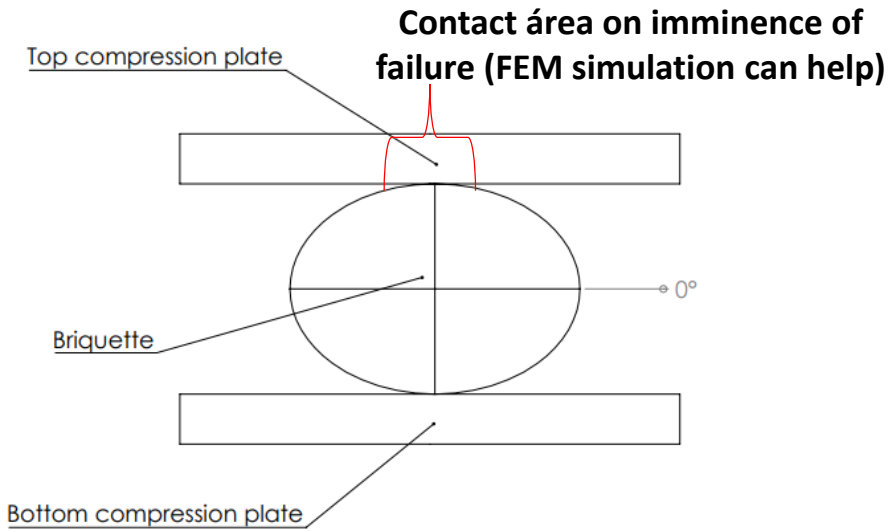


Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Next steps:

- Evaluate the compression of briquettes at other angles with the horizontal plane (30°, 60°).
- Check if briquette projected area is the best choice to normalize CCS:

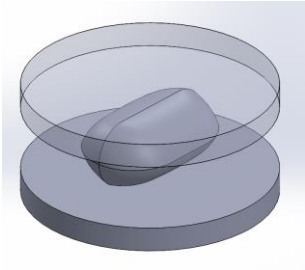


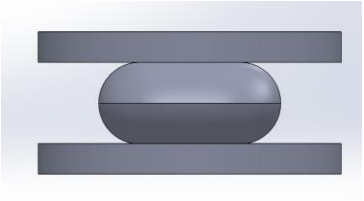


Influence of agglomeration technology on the mechanical strength of its agglomerates: a review of the methodology to evaluate the cold compression strength

Next steps:

- Use Finite Element Method simulations to support the understanding of stress distributions immediately prior to failure:





- Test different operation conditions of briquetting and pelletizing and evaluate possible relationships of mechanical strength between the two techniques, considering:
  - Agglomerate shape and size
  - Agglomeration technologies

Thank you!

The 5th SYMPOSIUM on IRON ORE PELLETIZING and its sustainable development