MOIRÉ SUPPORTED STRESS DISTRIBUTION STUDY ON GEARS

Prof. Inacio Maria Dal Fabbro.

Authors
Dafine Villa Santos
Jonathan Gazzola
Inácio Maria Dal Fabbro
Marcos Valério Gebra Silva

Introduction

Objective

✓ Use of phase-shifting *moiré* technique to determine stress in gears on different situations of loading (Cleaned, lubrificated and comtamined) .

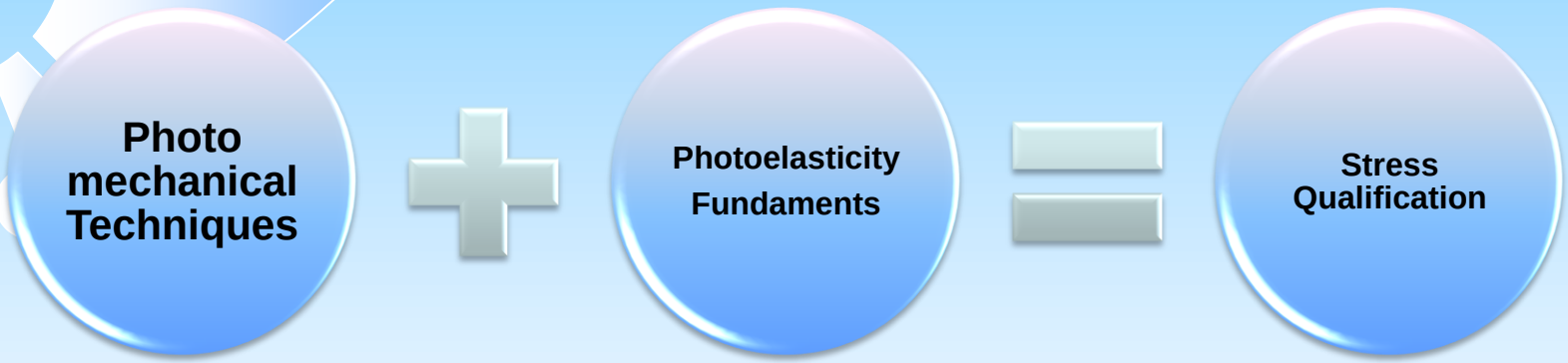
Importance

✓ Comprehension of stress distribution on different situations of loading.

✓ Improvement of gears design applied to farm machinery.

Concepts

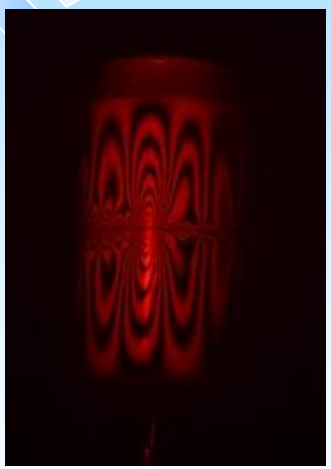
Hybrid Methods



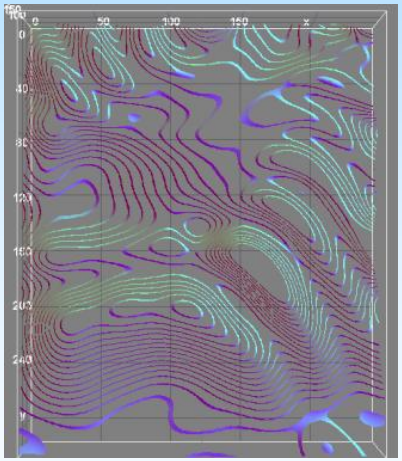
Concepts

Photomechanical Techniques

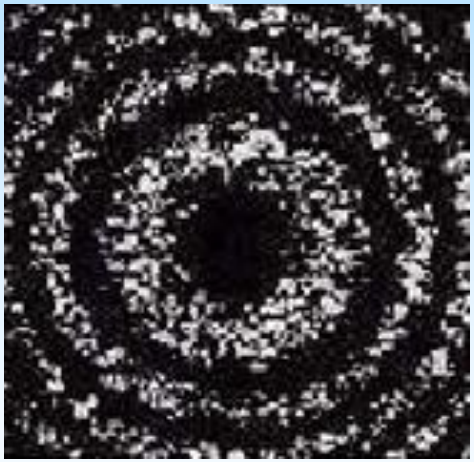
Displacement field is obtained through interferometrical waves propagation differentiated under loading applying.



Holography



Moiré Technique

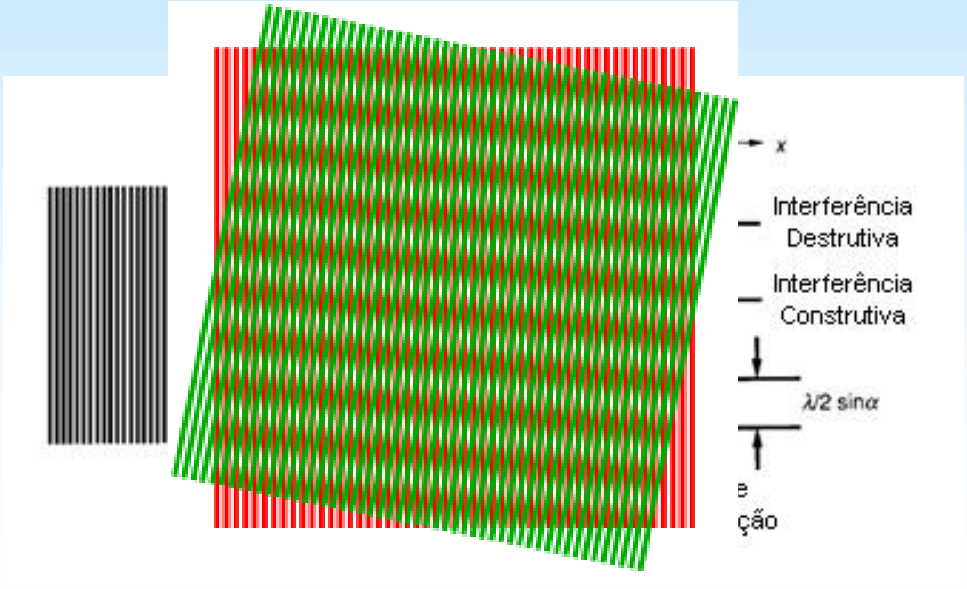


Interferometrical Speckle

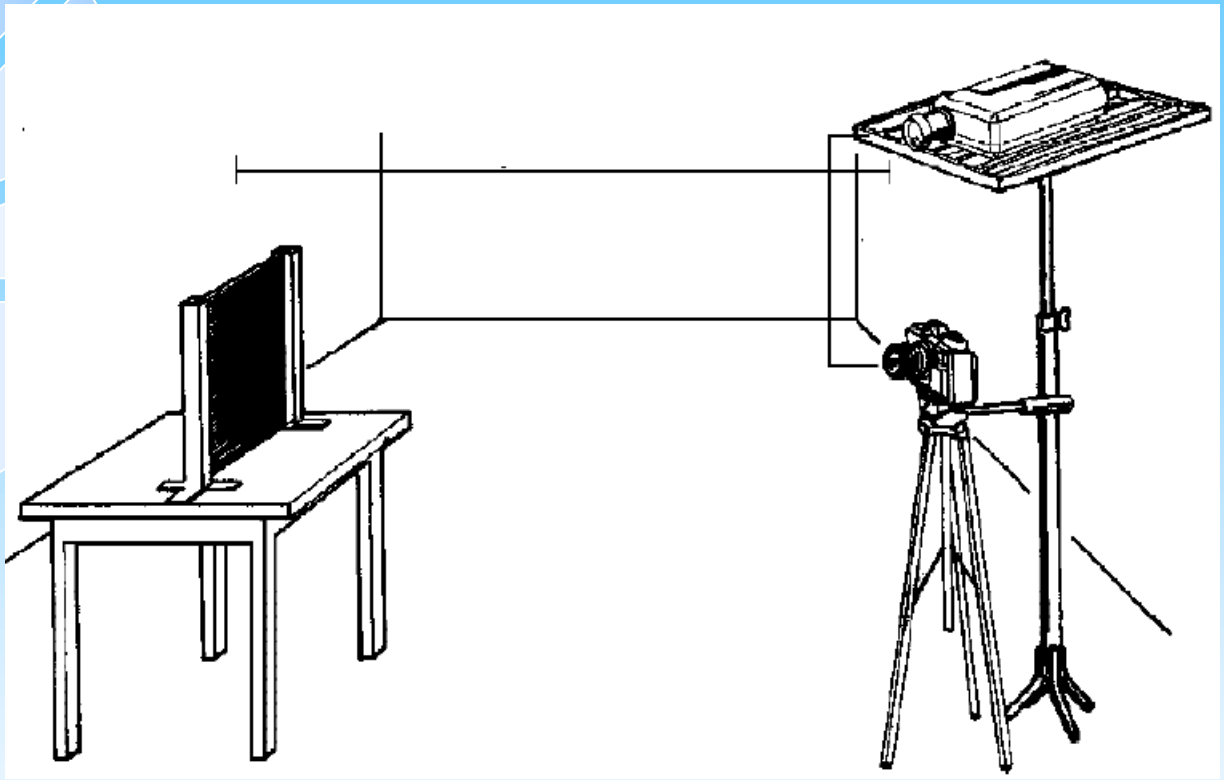
Concepts

Moiré Phenomenology

- ✓ Phenomenon generated when screens of certain mesh density are superposed, producing waves like patterns or fringes, which move when its relative positions are displaced



Materials and Methods

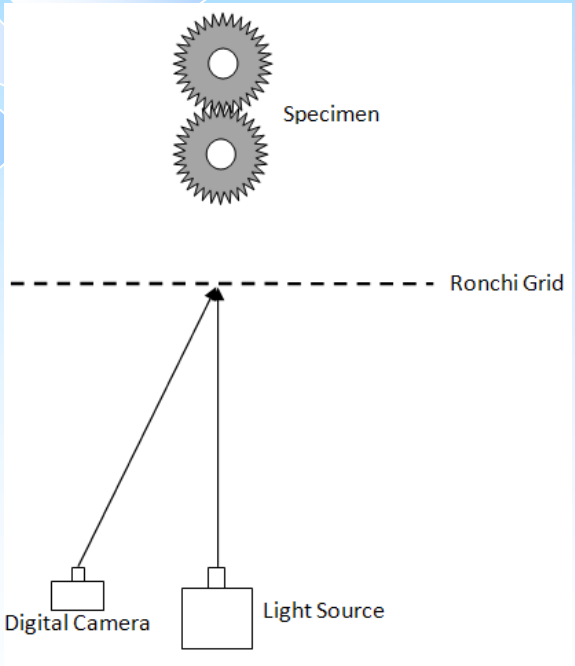


✓ SAMSUNG digital camera 7.1 mega pixels with remote control
✓ White light source.
✓ Ronchi grids of 0.4 mm of period.
✓ Wooden beam painted with white opaque color.

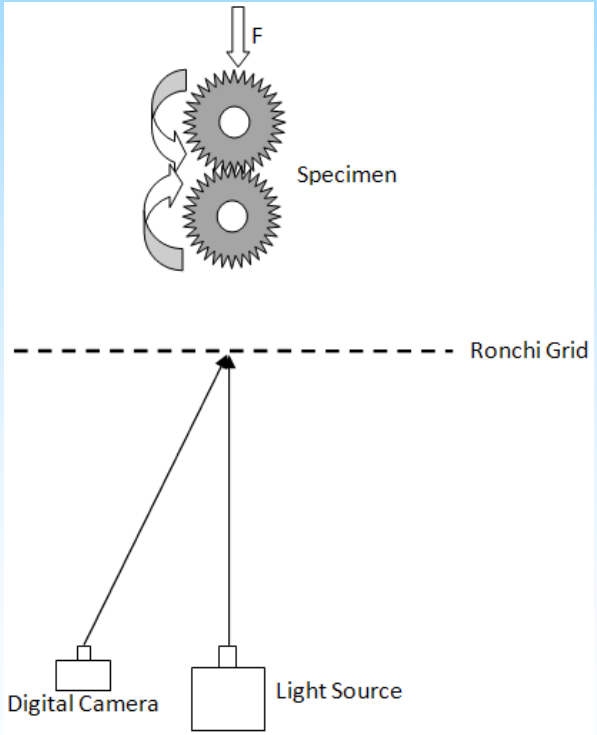
Methodology

Image Caption

Non loaded and loaded image are taken by digital camera



Non loaded Image



Loaded Image

Materials and Methods

PHOTOMECHANICAL TEST

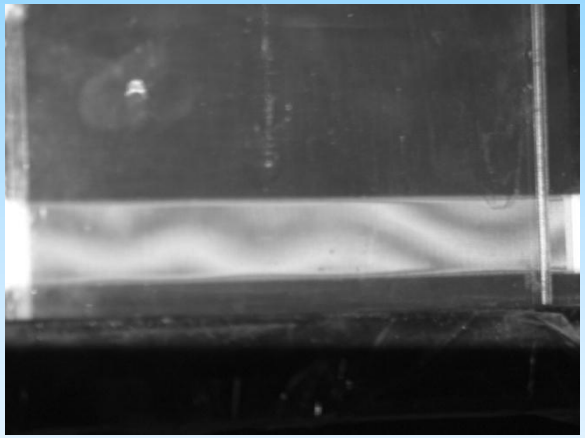
- **Force Application**
  - 0,0 kgf
  - 5,0 kgf
  - 10,0 kgf
  - 30,0 kgf
- **Image Package**
  - **G**(x,y) – 1 **image**
  - I_1(x,y)– 1 **Image**

Methodology

Image Processing

- Image conversion colored to 8 bit scale (ImageJ software)

Colored Image



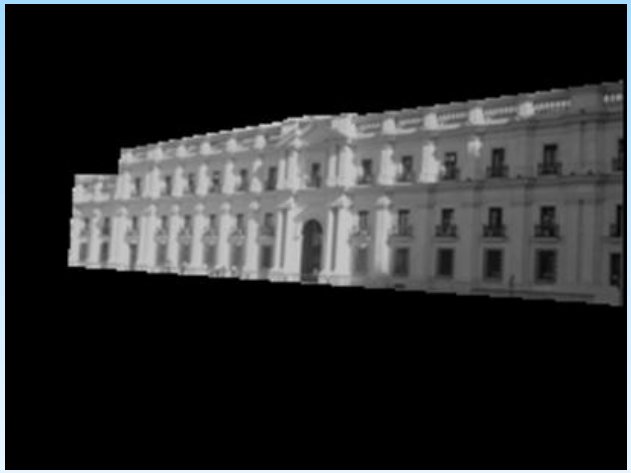
8 Bit Image

Methodology

Image Processing –Image Selection

- Selection of studied area (ImageJ software): Line contour.

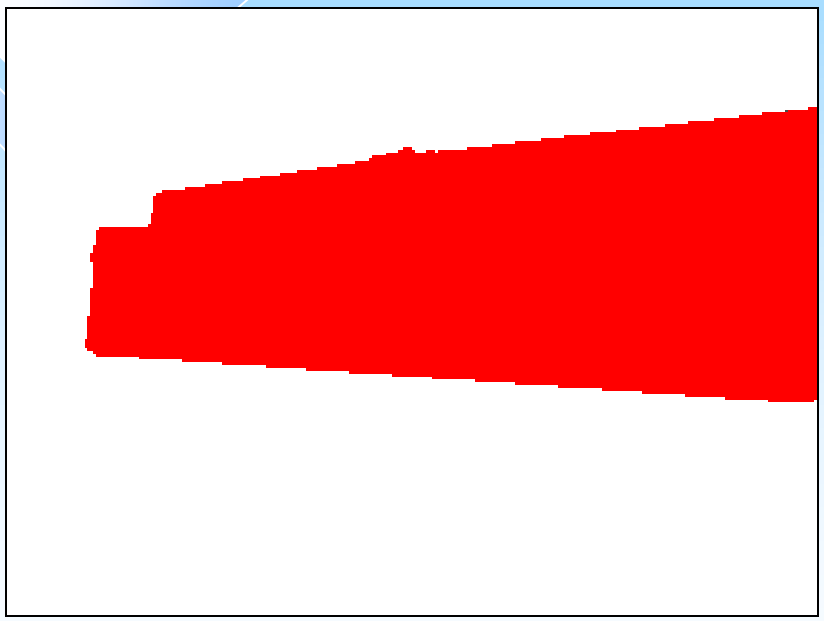
Selected area
with background



Selected area
without background

Methodology

Image Processing – Mask Formation



Binary Coloration

0 → Background (White)

1 → Selected Area (Red)

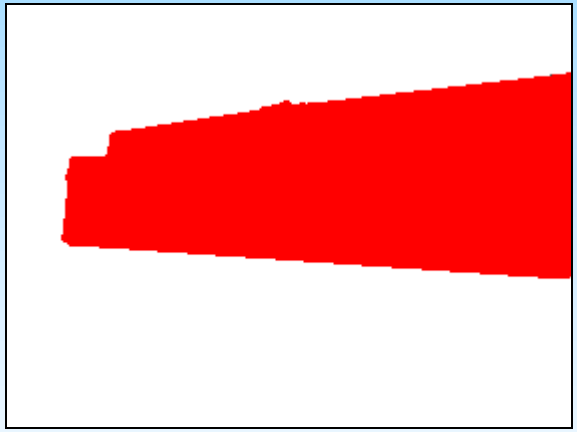
Methodology

Image Processing – Image Selection

- Selection of studied area (ImageJ software)

8 Bit Image

X

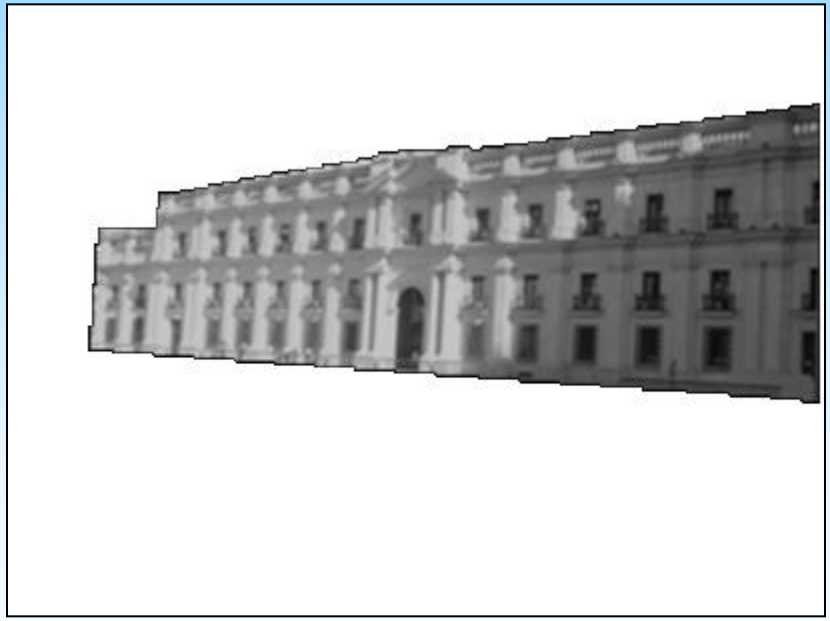


Mask

Methodology

Image Processing – Image Selection

- Selection of studied area (ImageJ software)



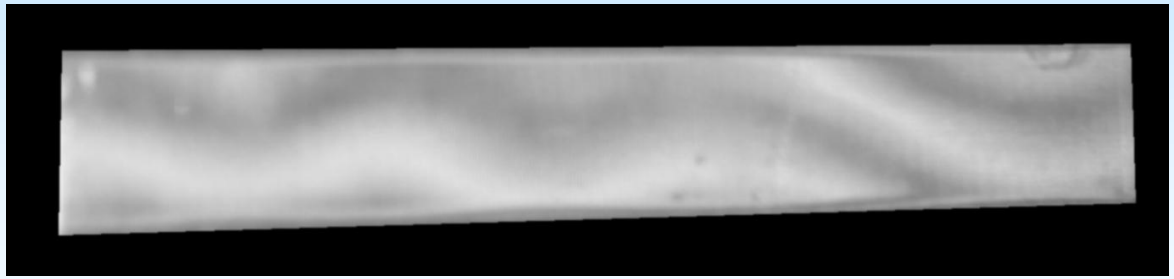
Selected area

Methodology

Image Processing – Image Filtration

- Filtration of image (Improvement of fringe contrast)

✓ Gaussian Blur Filter

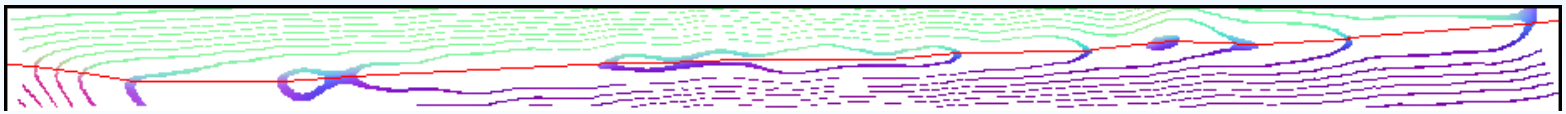


Methodology

Image Processing – Stress Mapping

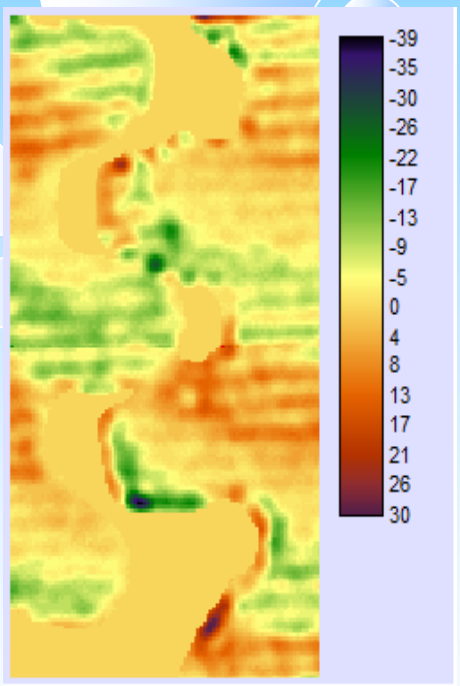
Isochromatical Fringes obtained through Idrisi Kilimanjaro software processing by *moiré* fringes differentiation

Isoclinical and isochromatical lines formation – Result obtained through ImageJ software processing

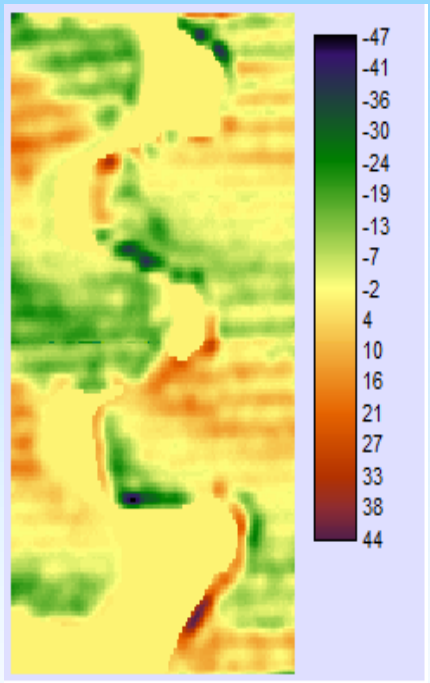


Results

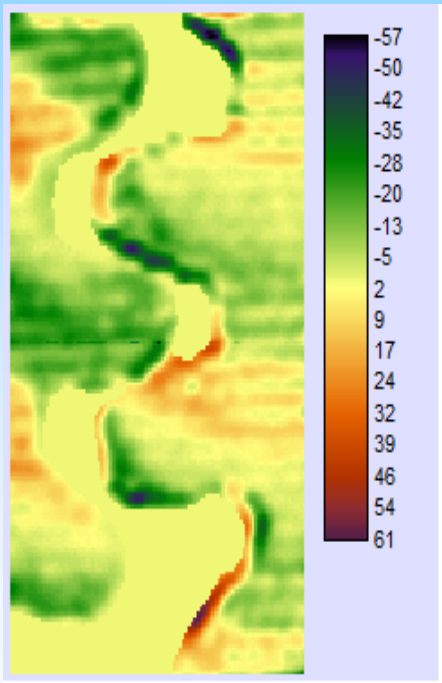
Isodeformation maps of clean gears loaded



05 kgf



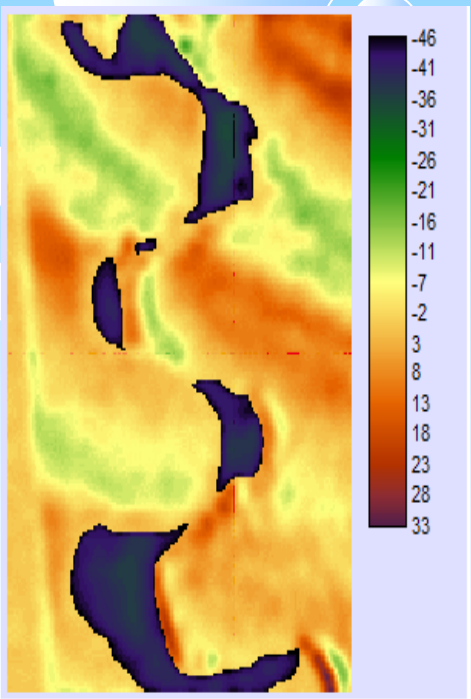
10 kgf



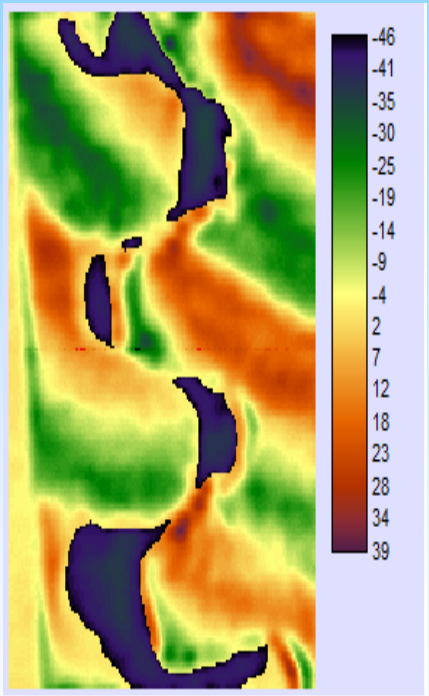
30 kgf

Results

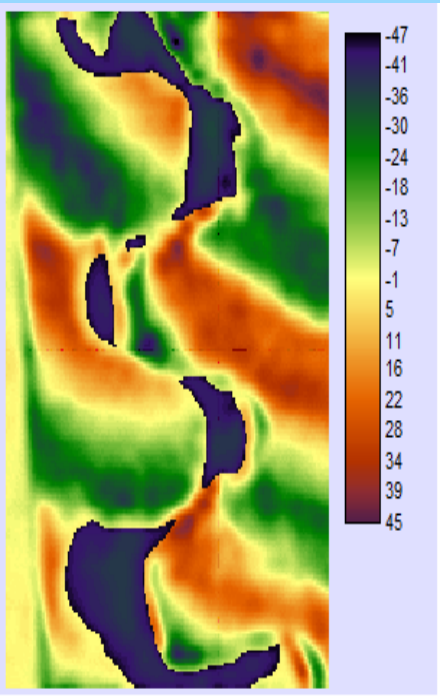
Isodeformation maps of lubrificated gears loaded



05 kgf



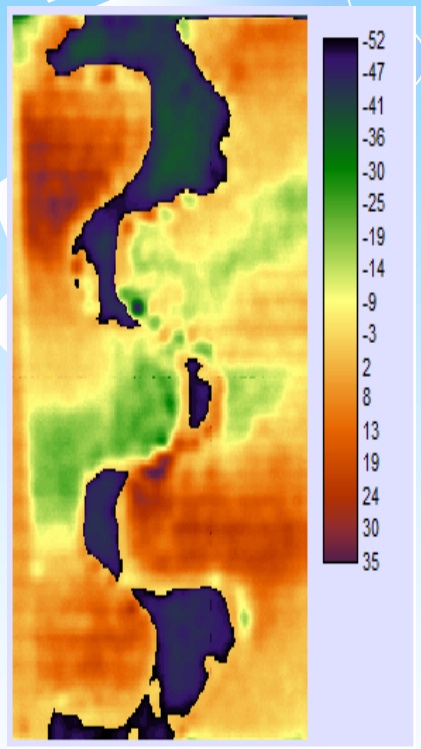
10 kgf



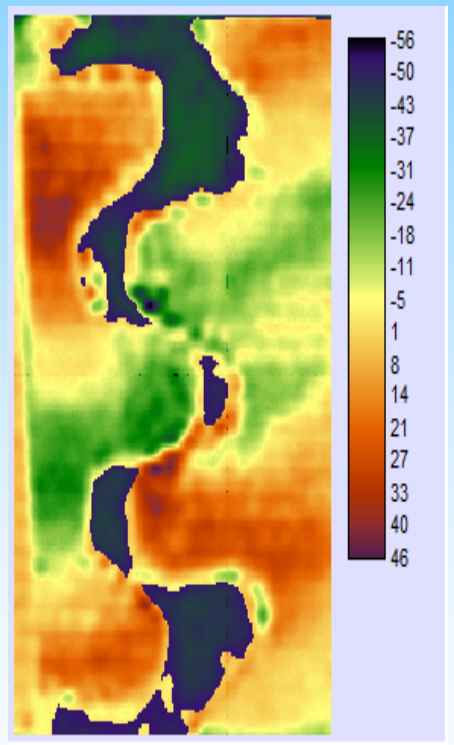
30 kgf

Results

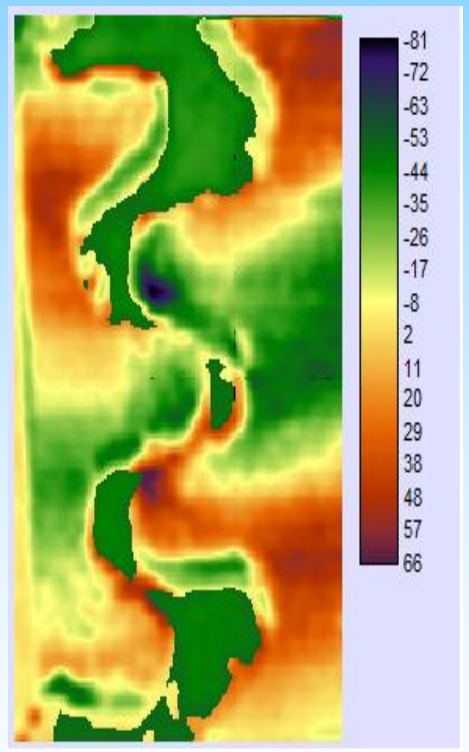
Isodeformation maps of contaminated gears loaded



05 kgf



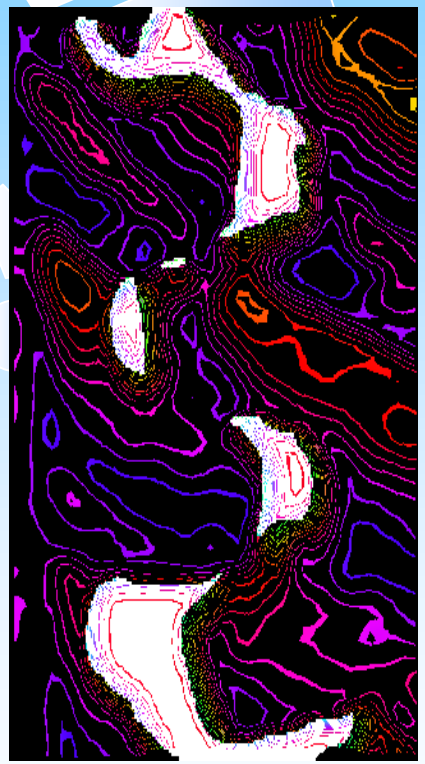
10 kgf



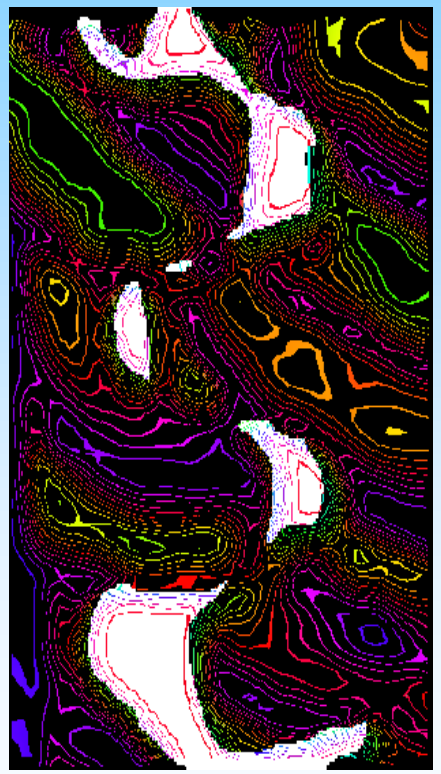
30 kgf

Results

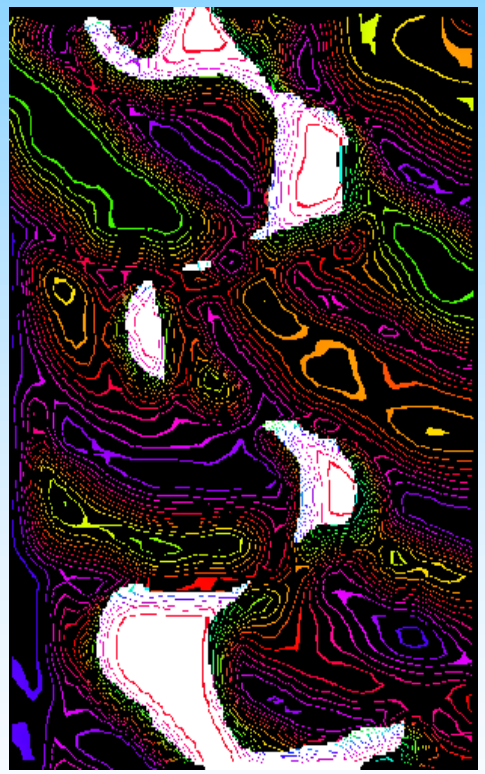
Isoclinics and isochromatics curves for clean gears loaded



05 kgf



10 kgf



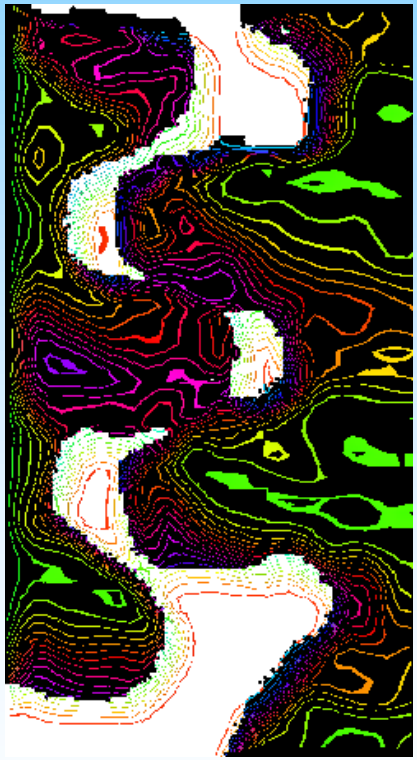
30 kgf

Results

Isoclinics and isochromatics curves for lubrificated gears loaded

05 kgf

10 kgf



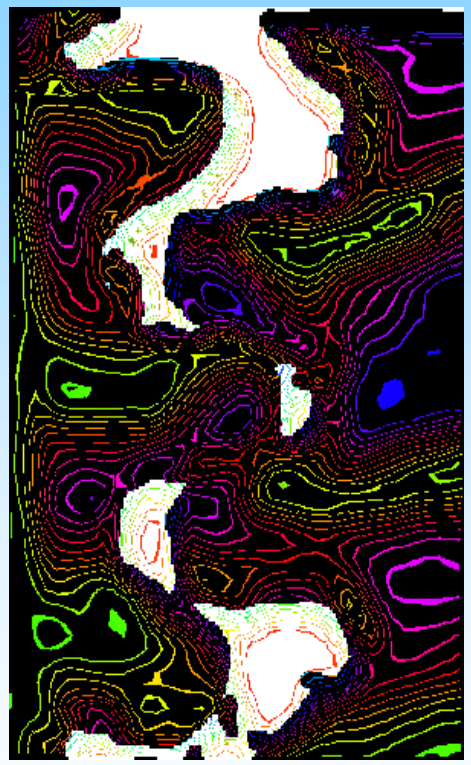
30 kgf

Results

Isoclinics and isochromatics curves for contaminated gears loaded

05 kgf

10 kgf



30 kgf

Discussions

✓ As loading increased isochromatic fringes spacing decreased, tending to occupy the whole observed area. Fringes distribution density indicates stress concentration.

✓ Fringes concentrations were initially positioned at gears tooth top and bottom.

✓ Fringes concentration moved to tooth border, following, to gear central areas.

✓ Low material density areas, as tooth region, experienced high fringes concentration.

✓ Clean gear presented the lowest fringe slop, followed by lubricated gear and finally by the lubricated dirty gear.

Conclusions

✓ Lubricated gears presented the best load distribution, and the lowest deformation variation..

✓ Contaminated gears presented stress concentration and stress intensity variation as well as deformation were shown to be higher, indicating decreasing element working life.

✓ The results are considered very useful, since the working conditions of farm machinery are severe.