Optimization of Head/Tape Interface

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Numerical Optimization of Magnetic Tape Heads

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Outline

• Optimal design of single, double, triple module head

• Effect of head design parameters on head/tape spacing and contact pressure

• Effect of head/tape interface parameters

• Summary
Optimal Design of Single, Double and Triple Module Head
Optimization criteria

Minimize the head/tape spacing
Design parameters---single module head

Normalized design parameters:
\[ \frac{r}{l}, \frac{w}{l}, \frac{s_{\text{max}}}{l} \]
Optimal design---- single module head

- w/l = 0.07
- hmax/l = 0.04
- r/l = 0.6

Max. contact pressure: 135 kPa

DLT3 tape, G-W contact model
Tape speed: 3.8 m/s
Tape tension: 87.5 N/m
Design parameters----double module head

Normalized design parameters:
\( \frac{r}{l}, \frac{w}{l}, \frac{s_{\text{max}}}{l} \)
Optimal design------double module head

Max. contact pressure: 441 kPa
DLT3 tape, G-W contact model
Tape speed: 3.8 m/s
Tape tension: 87.5 N/m

w/l=0.41
h_{max}/l=0.035
r/l=1.25
l=10 mm
Design parameters---- triple module head

Normalized design parameters:
\[ \frac{r}{l}, \frac{w_1}{l}, \frac{w_2}{l}, \frac{h}{l}, \frac{h_{\text{max}}}{l} \]
Optimal design---- triple module head

Max. contact pressure: 326 kPa
DLT3 tape, G-W contact model
Tape speed: 3.8 m/s, Tape tension: 87.5 N/m

h_{max}/l=0.025
h/l=0.025
w_1/l=0.3
w_2/l=0.3
r/l=1.0, l=12 mm
Effect of head dimensional parameters on head/tape spacing and contact pressure
Effect of $w$ on head/tape spacing distribution

Distance along head/tape interface (mm)

Head/tape spacing (nm)

$r/l=0.64$

$s_{max}/l=0.04$

$w/l=0.05$

$w/l=0.06$

$w/l=0.095$

$w/l=0.08$

$w/l=0.09$
Effect of $w$ on uniform head/tape spacing

$r/l=0.64$

$s_{\text{max}}/l=0.04$

$l=20$ mm

$0.05 \leq w/l \leq 0.093$

Optimal $w/l=0.08$
Effect of \( w \) on contact pressure distribution

Contact pressure (kPa)

Distance along head/tape interface (mm)

- \( w/l = 0.05 \)
- \( w/l = 0.06 \)
- \( w/l = 0.08 \)
- \( w/l = 0.09 \)
- \( w/l = 0.095 \)

Other values:
- \( r/l = 0.64 \)
- \( s_{\text{max}}/l = 0.04 \)
Effect of $w$ on $p_c(\text{max})$ and $p_c(\text{ctr})$

![Graph showing the relationship between $w/l$ and $p_c(\text{max})$ and $p_c(\text{ctr})$. The graph plots contact pressure (kPa) against $w/l$ with two lines: one for $P_c(\text{max})$ and another for $P_c(\text{ctr})$. The optimal value of $w/l$ is marked as 0.08.]
Effect of $r$ on uniform head/tape spacing

Nominal head/tape spacing (nm)

$s_{\text{max}}/l=0.04$

$w/l=0.08$

$l=20\text{ mm}$

Optimal $r/l=0.64$

$0.55 \leq r/l \leq 0.80$
Effect of $r$ on $p_c(\text{max})$ and $p_c(\text{ctr})$
Effect of $s_{\text{max}}$ on uniform head/tape spacing

- $r/l = 0.64$
- $w/l = 0.08$
- $l = 20 \text{ mm}$

Optimal $s_{\text{max}}/l = 0.04$

$0.035 \leq s_{\text{max}} \leq 0.05$
Effect of $s_{\text{max}}$ on $p_c(\text{max})$ and $p_c(\text{ctr})$
## Performance comparison

<table>
<thead>
<tr>
<th>Head type</th>
<th>Spacing (nm) (Center region)</th>
<th>p_c (kPa) (Center region)</th>
<th>Max. p_c (kPa) (Head edges)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>45</td>
<td>23</td>
<td>135</td>
</tr>
<tr>
<td>Double</td>
<td>43</td>
<td>32</td>
<td>441</td>
</tr>
<tr>
<td>Triple</td>
<td>44</td>
<td>30</td>
<td>326</td>
</tr>
</tbody>
</table>
Effect of Head/Tape Interface Parameters
Effect of tape tension on uniform spacing

(11b)
Effect of tape tension on $p_c(\text{max})$ and $p_c(\text{ctr})$

![Graph showing the effect of tape tension on contact pressure](image-url)
Effect of tape speed on uniform spacing

![Graph showing the effect of tape speed on head/tape spacing. The x-axis represents tape speed (m/s) ranging from 0 to 20, and the y-axis represents head/tape spacing (nm) ranging from 40 to 50. The line shows a decrease in head/tape spacing as tape speed increases.](image-url)
Three different contact models

- DLT3 experimental data
- Greenwood-Williamson model
- Parabolic model
- Power function model

Spacing (nm)

Contact pressure (kPa)

h = contact spacing

Smooth Tape

Head
Effect of contact models on spacing prediction

Power function model
Greenwood-Williamson model
Parabolic model

DLT3 tape
v=3.8 m/s
T=87.5 N/m
Effect of tape medium

Distance along head/tape interface (mm)

Head/tape interface spacing (nm)

DLT3

DLT3XT

DLT4

v = 3.8 m/s
T = 87.5 N/m
G-W contact model
Summary

• Single, double and triple module heads were optimized
• Effect of head dimensional parameters on head/tape spacing and contact pressure was studied
• Effect of head/tape interface parameters was investigated