



# KOYO LONG LIFE BEARINGS

## KE Bearing & SH Bearing

### Performance of Long Life Bearings ( Compared with Conventional Bearings )

	KE Bearing	SH Bearing
● Life in Contaminated Oil	<b>10</b> times or longer	<b>10</b> times or longer
● Dent Resistance	<b>10</b> times or more	<b>8</b> times or more
● Wear Resistance	<b>2</b> times or more	<b>1.5</b> times or more
● Life in Clean Oil	<b>2</b> times or longer	<b>6</b> times or longer

KE Bearing – Case Hardened Steel

SH Bearing – Through Hardened Steel

### Flaking Mechanism and Countermeasures

Modes	FLAKING IN CONTAMINATED OIL			FLAKING IN CLEAN OIL
	FLAKING INITIATED FROM SURFACE			FLAKING INITIATED FROM SUB - SURFACE
	PEELING	MIXED FLAKING	FLAKING FROM DENT	
Appearance				
Mechanism	 Abrasive wear by small and hard particles	 Abrasive wear by small hard particles, and plastic deformation by large hard particles	 Plastic deformation caused by outside force or large and hard particles	 Material defect at maximum shear stress
Measures	<p>Harder Surface Hardness for</p> <ul style="list-style-type: none"> <li>• Improve Wear Resistance</li> <li>• Reduce Plastic Deformation</li> </ul> <p>↓</p> <p><b>KE Bearing</b> ← Optimized Retained Austenite</p> <ul style="list-style-type: none"> <li>• Early Disappearance of Plastic Deformation</li> </ul> <p>Forming of Carbonitride</p> <p>→ <b>SH Bearing</b></p>			<p>Optimized matrix C %</p> <p>Optimized surface hardness of rolling element</p> <p>Stabilized structure for high temperature</p> <p>Formed high residual compressive stress on surface</p>



## FLAKING IN CONTAMINATED OIL & COUNTERMEASURES

### 1. Flaking from Dent & How to get Long Life

<b>Flaking Process</b>																												
<b>Analyzed Data</b>	<p>Harder raceway surface proved smaller initial risen height</p> <table border="1"> <caption>Initial risen height vs Raceway surface hardness</caption> <thead> <tr> <th>Raceway surface hardness (HRC)</th> <th>Initial risen height <math>h_0</math> (<math>\mu\text{m}</math>)</th> </tr> </thead> <tbody> <tr><td>60</td><td>3.5</td></tr> <tr><td>61</td><td>3.0</td></tr> <tr><td>62</td><td>2.5</td></tr> <tr><td>63</td><td>2.0</td></tr> <tr><td>64</td><td>1.5</td></tr> </tbody> </table>		Raceway surface hardness (HRC)	Initial risen height $h_0$ ( $\mu\text{m}$ )	60	3.5	61	3.0	62	2.5	63	2.0	64	1.5	<p>Risen height became smaller by repeated running</p> <table border="1"> <thead> <tr> <th><math>\gamma R</math></th> <th>Surface Hardness</th> <th>A</th> <th>B</th> </tr> </thead> <tbody> <tr> <td>16.9%</td> <td>62.2 HRC</td> <td>○</td> <td>●</td> </tr> <tr> <td>31.5%</td> <td>62.9 HRC</td> <td>□</td> <td>■</td> </tr> </tbody> </table>		$\gamma R$	Surface Hardness	A	B	16.9%	62.2 HRC	○	●	31.5%	62.9 HRC	□	■
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<b>Counter-measures</b>	<p>By harder surface hardness or forming carb-nitride stratum, initial risen height <math>h_0</math> caused by particles can be reduced.</p> $h_0^{\text{conventional bearing}} > h_0^{\text{KE bearing}} \geq h_0^{\text{SH bearing}}$		<p>By optimizing retained austenite (<math>\gamma R</math>) risen height (<math>h</math>) can be disappeared in early stage.</p> $h^{\text{conventional bearing}} > h^{\text{SH bearing}} \geq h^{\text{KE bearing}}$																									

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<p>By optimizing retained austenite (<math>\gamma R</math>), work hardening of risen area could be repressed</p> <p><b>Conventional bearing</b> Risen area had work hardening and not disappeared easily</p> <p><b>Long life bearing</b> Risen area showed small work hardening and easily disappeared</p>	<p>Smaller risen height showed smaller shear stress</p> <p>• A detail</p> <p>Small ← Risen height → Large</p>	<p>Smaller risen height showed longer life</p>
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Risen height ( $h$ )  
 $h^{\text{conventional bearing}} > h^{\text{SH bearing}} \geq h^{\text{KE bearing}}$   
 Therefore, shear stress ( $\tau$ )  
 $\tau^{\text{conventional bearing}} \gg \tau^{\text{SH bearing}} \geq \tau^{\text{KE bearing}}$

By increasing surface hardness and optimizing retained austenite.  
 $Life^{\text{conventional bearing}} < Life^{\text{SH bearing}} \leq Life^{\text{KE bearing}}$



# 2. Peeling & How to get Long Life

<p><b>Peeling Process</b></p>	<p>①</p>	<p>②</p>	<p>③</p>	<p>④ Peeling</p>
<p><b>Analyzed Data</b></p>	<p>Harder raceway surface proved longer life</p>		<p>Retained austenite (<math>\gamma_R</math>) not related with peeling</p>	
<p><b>Counter-measures</b></p>	<p>By increasing raceway surface hardness than particle hardness or forming carbonitride stratum, wear resistance can be improved.</p> <p>Life conventional bearing &lt; Life <b>SH bearing</b> <math>\leq</math> Life <b>KE bearing</b></p>			

## BEARING LIFE EVALUATION RESULTS AGAINST FLAKING (Compared with Conventional Bearings)

Life in contaminated oil  
KE bearing, SH bearing  
:10 times or longer

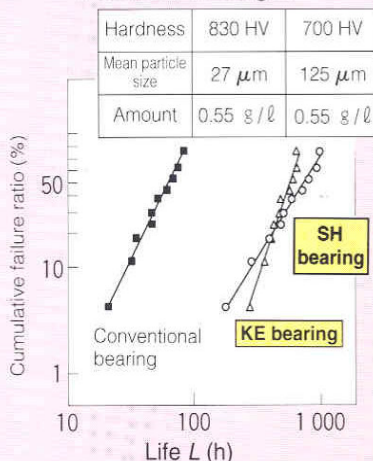


Fig. 1 Life test result in contaminated oil

Life in clean oil

KE bearing : 2 times or longer  
SH bearing : 6 times or longer

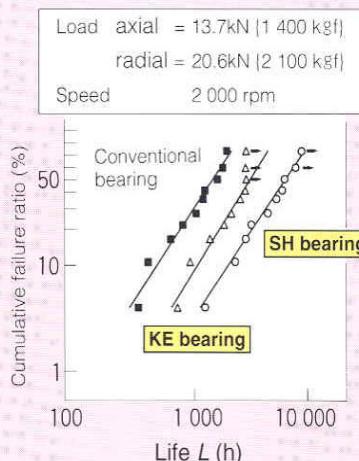


Fig. 2 Life test result in clean oil

Dent resistance

KE bearing : 10 times or more  
SH bearing : 8 times or more

Dent area ratio measured at 20 points of inner ring raceway center and analyzed by computer

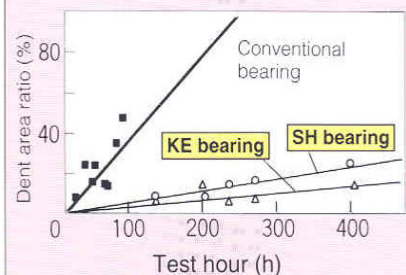
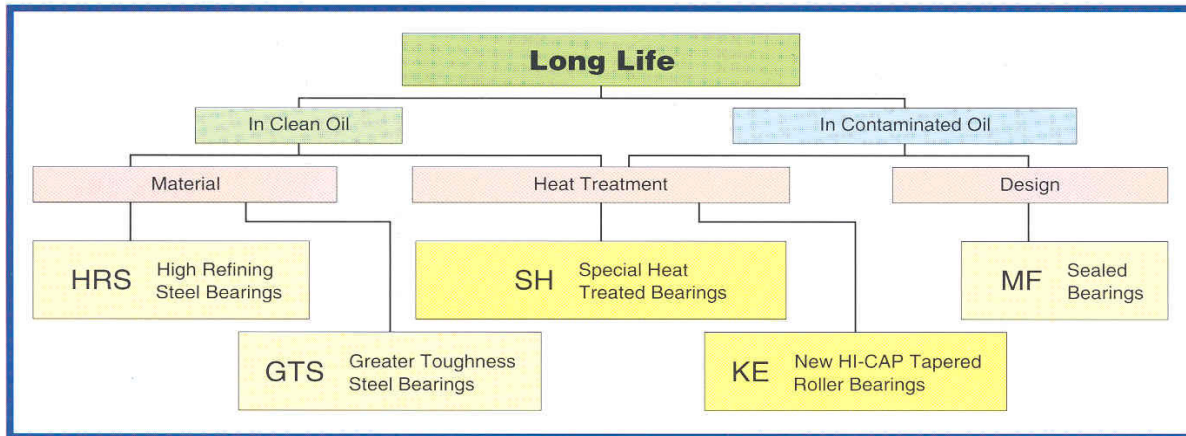


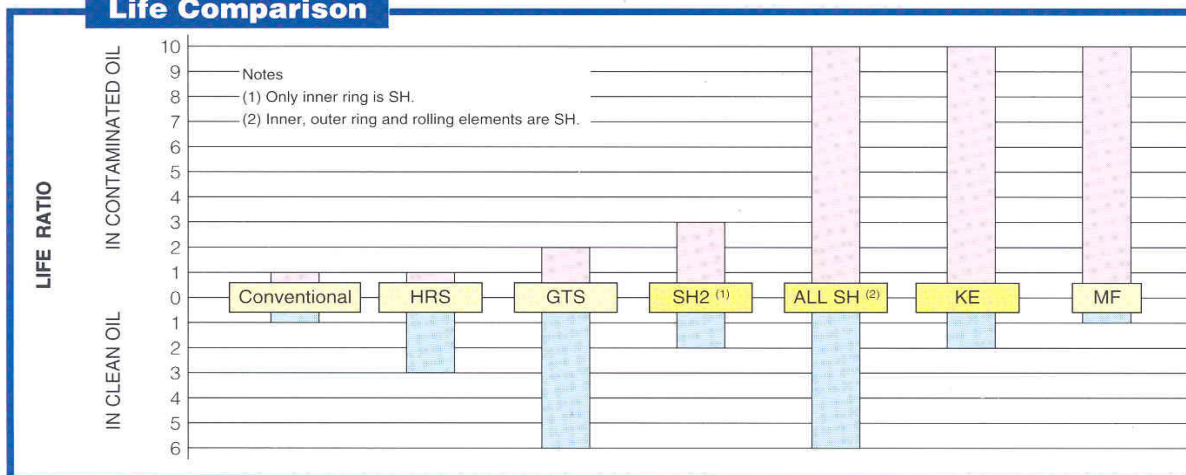
Fig. 3 Test hour vs dent area ratio in contaminated oil



### ■ KOYO Long Life Bearings



### Life Comparison



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