

COBRA-EHL

COMPUTER OPTIMIZED BALL & ROLLER BEARING ANALYSIS
with ELASTOHYDRODYNAMIC LUBRICATION & ROLLER CROWN



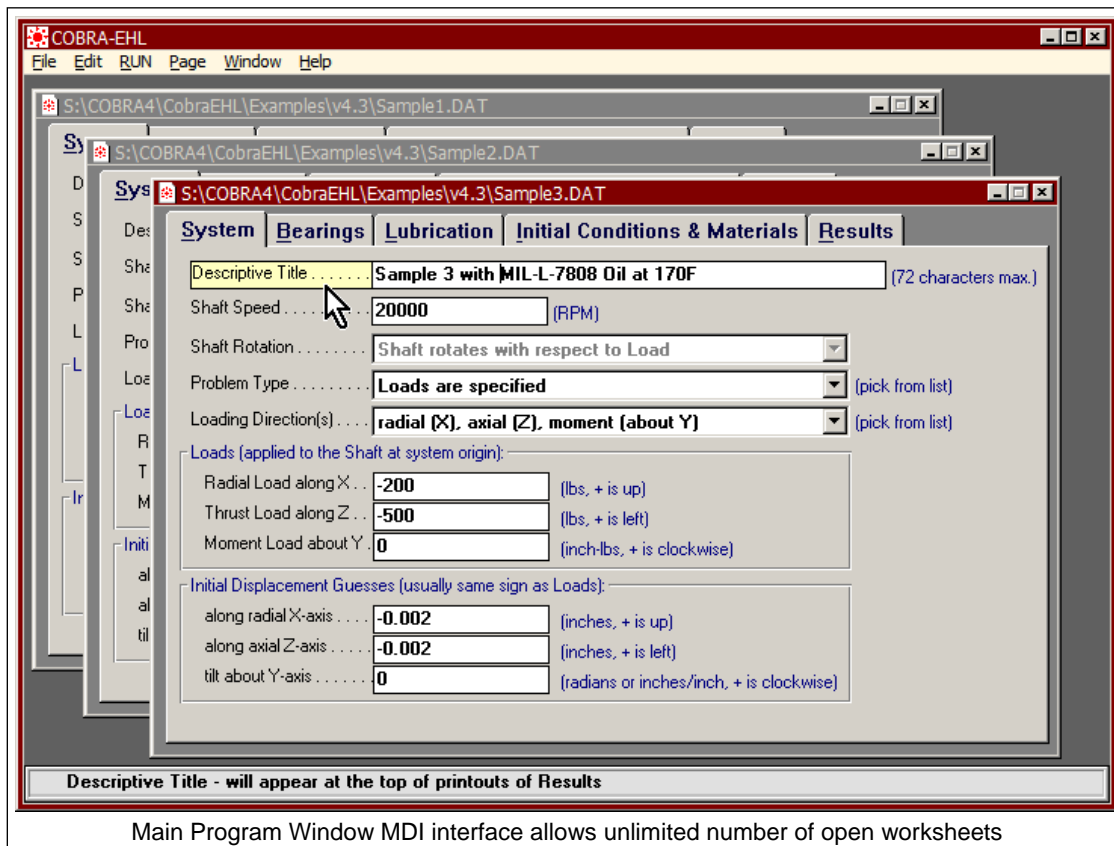
COBRA-EHL is a bearing analysis program that computes the behavior of up to six (6) bearings on a shaft under combined Radial, Thrust and Moment loading. The program has a modern menu-driven Windows interface with a multi-tabbed worksheet format, allowing users to interactively change input data and quickly generate results. Lubricant Film Thickness and associated Life Adjustment Factors are internally computed. Roller Crown analysis uses the approximate laminated roller model.

PROGRAM CAPABILITIES INCLUDE:

| | | |
|-----------------------------------|-------------------------------|-------------------------------------|
| Up to 6 Bearings on a rigid shaft | Location Offsets | Inputs and Results in English units |
| Radial, Thrust & Moment Loads | Axial Float | Integrated w/ ARMD Rotordynamics |
| Specified Loads or Displacements | Actual or Estimated Geometry | Copy Bearing Function |
| Crowned Rollers w/ Lamina | Hybrid Bearings | Fast (typically 2 seconds per run) |
| Solid and Spring Preload | Lubricant Film Thickness | Results Immediately Available |
| Internal Clearance & End-Play | Lubricant Effects on B10 Life | Copy Results to Clipboard |
| Misalignment | Library of Lubricants | Hard Copy for Printing |

SIX (6) BEARING TYPES:

| | | |
|----------------------|------------------------|------------------------------------|
| Radial (Conrad) Ball | Cylindrical Roller | Tapered Roller |
| Angular Contact Ball | Angular Contact Roller | Spherical Roller, Spherical Thrust |



Main Program Window MDI interface allows unlimited number of open worksheets

| | Bearing #1 | Bearing #2 | Bearing #3 | Bearing #4 | Bearing #5 | Bearing #6 |
|-----------------------------------|---------------|---------------|------------------------------|------------|------------|------------|
| Bearing Type (pick from list) ... | Angular Cont. | Angular Cont. | Cylindrical | | | |
| Location (inches from origin) ... | 7.024 | 4.976 | Angular Contact Ball Bearing | | | |
| Bearing I.D. (mm) ... | 80 | 80 | Conrad/Radial Ball Bearing | | | |
| Bearing O.D. (mm) ... | 140 | 140 | Cylindrical Roller Bearing | | | |
| Estimated Geometry? (yes/no) ... | No | No | Tapered Roller Bearing | | | |
| Width of a Single Row (mm) ... | n/a | n/a | Spherical Roller Bearing | | | |
| Number of Rolling Elements ... | 34 | 15 | 34 | | | |
| Pitch Diameter (inches) ... | 4.331 | 4.331 | 4.921 | | | |
| Element Diameter (inches) ... | 0.75 | 0.75 | 0.5472 | | | |
| Roller Total Length (inches) ... | n/a | n/a | 0.5669 | | | |
| Roller Flat Length (inches) ... | n/a | n/a | 0.3 | | | |
| Roller Crown Radius or Drop ... | n/a | n/a | 500 | | | |
| Cone Rib Diameter (in) ... | n/a | n/a | 0 | | | |
| Contact Angle (degrees) ... | 25 | -25 | 0 | | | |
| Outer Race Curvature/Osc. ... | 0.53 | 0.53 | n/a | | | |
| Inner Race Curvature/Osc. ... | 0.52 | 0.52 | n/a | | | |
| Capacity Reduction Factor ... | n/a | n/a | 0.66 | | | |
| Dynamic Capacity (lbs) post1990 | 32,990. | 19,119. | 40,161. | | | |

| | Bearing #1 | Bearing #2 | Bearing #3 | Bearing #4 | Bearing #5 | Bearing #6 |
|---------------------------------------|----------------|----------------|------------------------------|------------|------------|------------|
| Lubricant Type (pick from list) ... | user-specified | user-specified | user-specified | | | |
| Lube Density [g/cm ³] ... | 0.88 | 0.88 | Mineral Oil (Shell Turbo 33) | | | |
| Lube Thermal Exp. Coeff [1/F] ... | 0.000352 | 0.000352 | MIL-L 78086 | | | |
| Lube Viscosity @100 F [cSt] ... | 64 | 64 | Polyphenyl Ether MCS 293 | | | |
| Lube Viscosity @210 F [cSt] ... | 8 | 8 | MIL-L 23699 | | | |
| Pressure Coefficient [1/psi] ... | 0 | 0 | user-specified lubricant | | | |
| Lube Temperature [F] ... | 200 | 200 | 200 | | | |
| Element Roughness [μ-inches] ... | 6 | 6 | 6 | | | |
| Race Roughness [μ-inches] ... | 8 | 8 | 8 | | | |

Notes re 'Lubricant Type': If you select 'no lubrication,' then you must specify the 'Life Adjustment Factor for Lubrication' (on 'Initial Conditions' page).

If you select one of COBRA's four pre-defined Lubricant Types, then COBRA will enter default values for the lubricant's properties. You may modify these values in your worksheet, if you wish. Also, the COBRA engine will calculate the 'Life Adjustment Factor for Lubrication' (on 'Initial Conditions' page).

If you select 'user-specified lubricant,' then you must specify values for the lubricant's properties. The COBRA engine will calculate the 'Life Adjustment Factor for Lubrication' (on 'Initial Conditions' page).

| | Bearing #1 | Bearing #2 | Bearing #3 | Bearing #4 | Bearing #5 | Bearing #6 |
|---|------------|------------|------------|------------|------------|------------|
| Diametral Clearance (inches) ... | 0 | 0 | 0.001 | | | |
| Axial Float? (yes/no) ... | No | No | n/a | | | |
| Axial Preload (lbs) ... | 0 | 0 | n/a | | | |
| Axial Offset along Z (inches) ... | 0 | 0 | n/a | | | |
| Radial Offset along X (inches) ... | 0 | 0 | 0 | | | |
| Initial Tilt about Y [radians] ... | 0 | 0 | 0 | | | |
| Axial Spring Preload? (yes/no) ... | No | No | n/a | | | |
| Axial Spring Coeff. A (for x ³) ... | n/a | n/a | n/a | | | |
| Axial Spring Coeff. B (for x ²) ... | n/a | n/a | n/a | | | |
| Axial Spring Coeff. C (for x ¹) ... | n/a | n/a | n/a | | | |
| Axial Spring Coeff. D (for x ⁰) ... | n/a | n/a | n/a | | | |
| Young's Modulus of Elem. (psi) | 29000000 | 29000000 | 29000000 | | | |
| Poisson's Ratio of Elements ... | 0.28 | 0.28 | 0.28 | | | |
| Young's Modulus of Race (psi) | 29000000 | 29000000 | 29000000 | | | |
| Poisson's Ratio of Race ... | 0.28 | 0.28 | 0.28 | | | |
| Life Adj. Factor for Reliability ... | 1 | 1 | 1 | | | |
| Life Adj. Factor for Material ... | 2.2 | 2.2 | 1.37 | | | |
| Life Adj. Factor for Lubrication ... | n/a | n/a | n/a | | | |

S:\COBRA4\CobraEHL\Examples\v4.3\Sample1 with Crown.LPT 2004/09/01 **Status: CURRENT**

Bearing Location Diagram:

Spring Rates at Origin:

| | | |
|---------------------|----------------------|------------------------|
| DFX/DX = -1.077E+07 | DFX/DALY = 2.529E+07 | DFZ/DALY = 1.6172E+06 |
| DFX/DZ = 4.293E+05 | DFZ/DZ = -1.195E+06 | DMY/DALY = -1.7129E+08 |

Results: Sample 1 for CobraEHL 4.3

| | |
|--|--------------|
| Unadjusted System L10 Life (hrs) = 2.671E+04 | 6 Iterations |
| Adjusted System L10 Life (hrs) = 1.341E+04 | |
| Shaft Speed (rpm) = 1.500E+03 | |

---FORCES--- ---DISPLACEMENTS---

| | | | | | |
|------------------|------------------|------------------|------------------|-----------------|-------------------|
| Radial (Along X) | Thrust (Along Z) | Moment (About Y) | Radial (Along X) | Axial (Along Z) | Angular (About Y) |
|------------------|------------------|------------------|------------------|-----------------|-------------------|

PROGRAM RESULTS INCLUDE:

- | | | |
|----------------------------------|-------------------------------|------------------------------------|
| Bearing Reactions & Load Sharing | Load Zones | Required Shoulder Heights |
| Radial & Axial Spring Rates | Hertz Contact Stress | Adjusted Hybrid Bearing Life |
| Angular Spring Rate | Sub-Surface Shear Stress | Lubricant Film Thickness |
| Dynamic Capacity | Depth to Maximum Shear Stress | Life Adjustment Factor-Lubrication |
| System L10 Life | Operating Contact Angle | Individual Element Output |
| Bearing L10 Life | Element Loads | Stress Distribution across Crowned |
| Timken BRR & Life | Contact Ellipse Size | Rollers |

LIMITATIONS:

- DN Values must be under 1 million DN (RPM x Bore Size in mm)
- 3 Degrees of Freedom
- COBRA-AHS is recommended to analyze higher DN values and/or 5 Degrees of Freedom

SYSTEM REQUIREMENTS:

- Windows Operating System (2000, XP, Vista, Windows 7). CobraEHL is 32-bit, runs transparently on 64-bit Windows.
- CD drive; USB port (parallel port optional).
- 4 MB free space on hard disk; 800x600 pixel screen resolution; 16-bit color display

PACKAGE INCLUDES:

- Installation CD; End-User License; Example Problems; Printed Manual; USB Security Lock (dongle),
- Free Technical Support for 1 year after purchase. Fee-based support available thereafter.