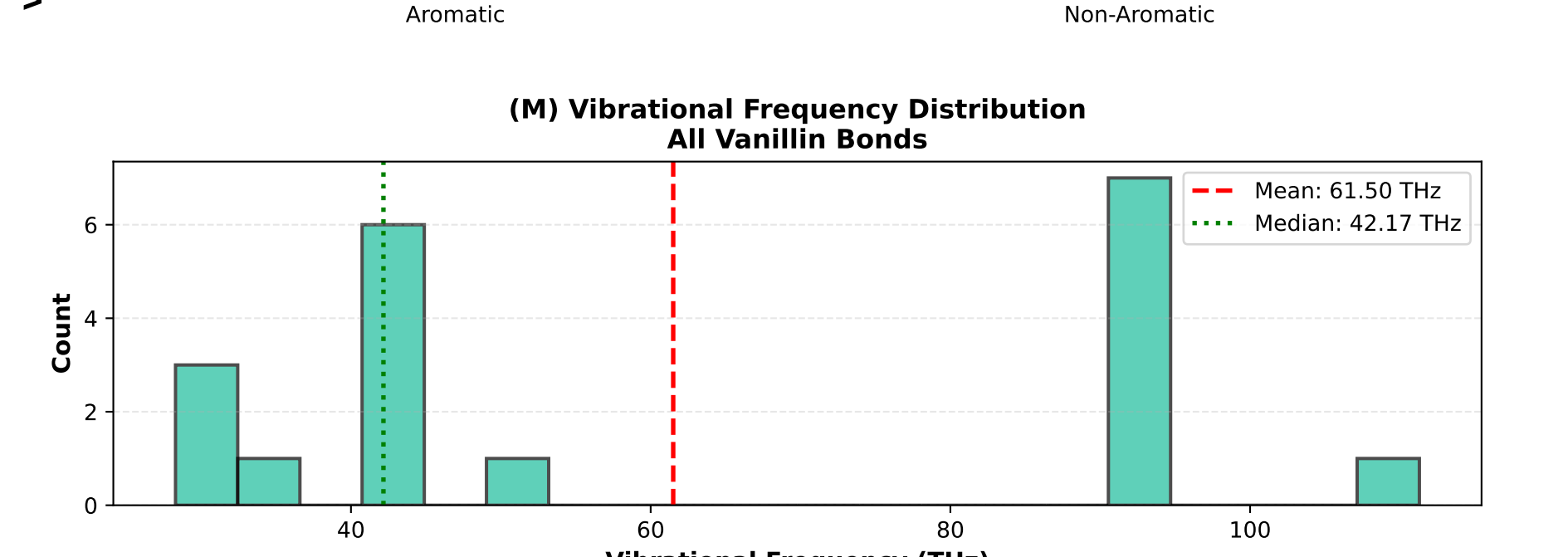
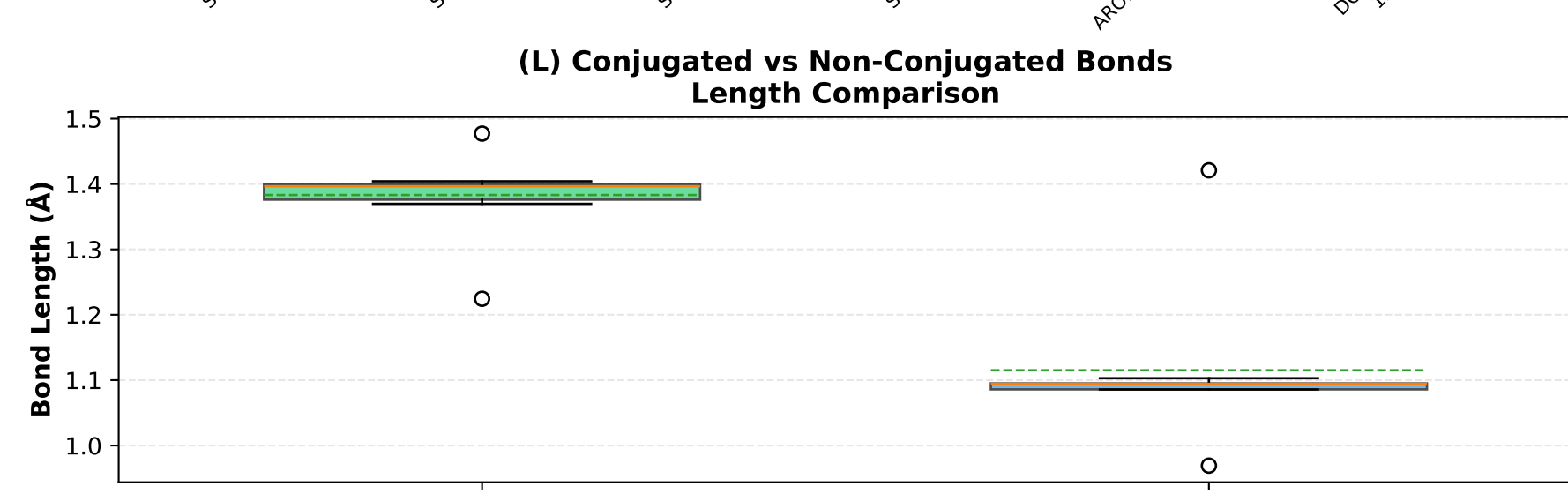
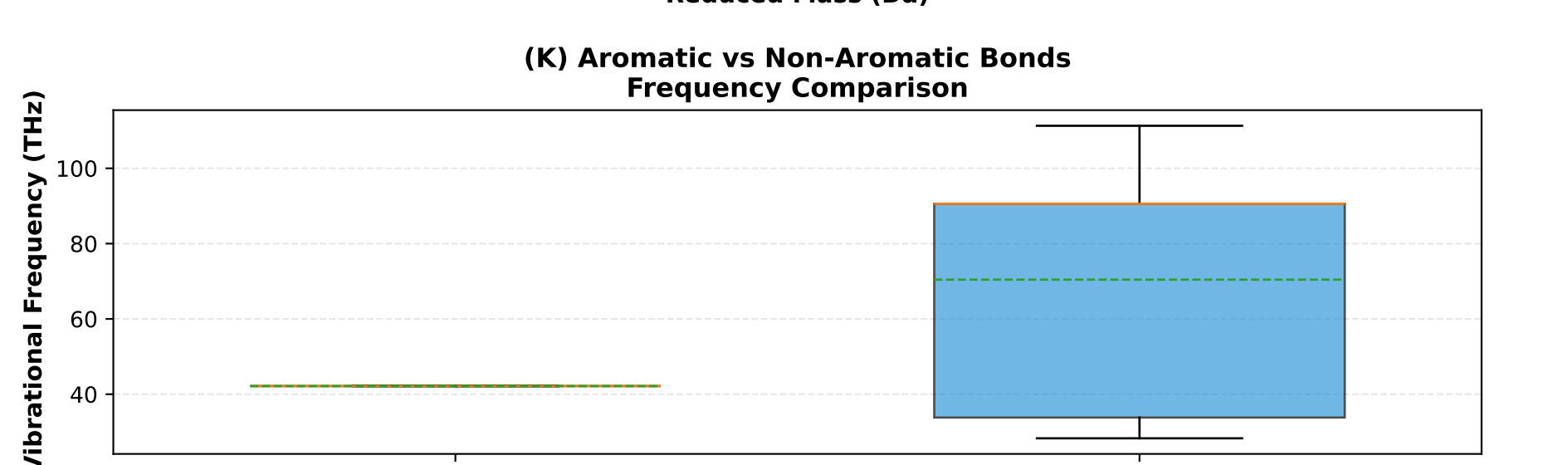
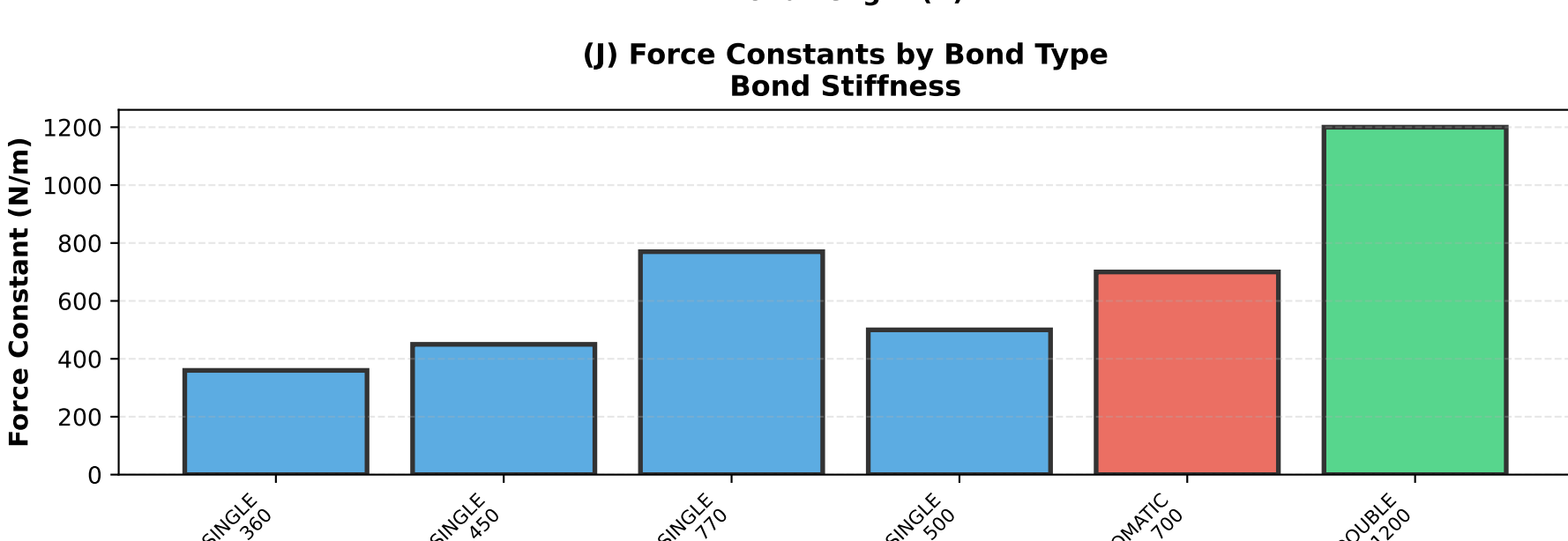
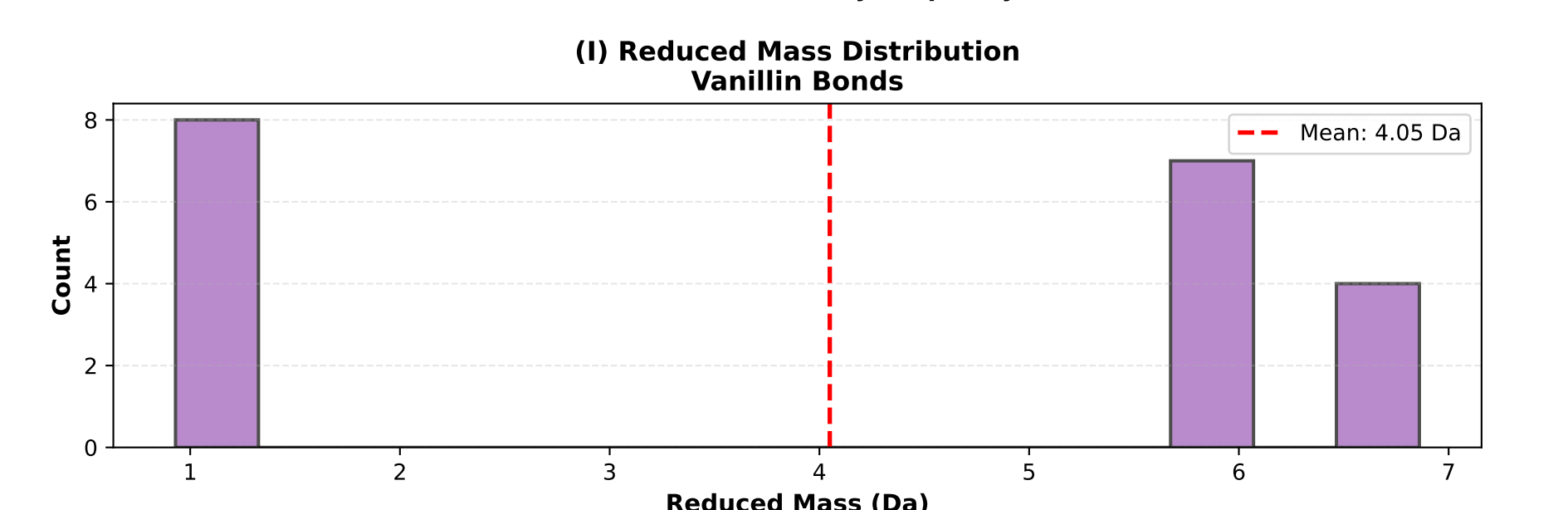
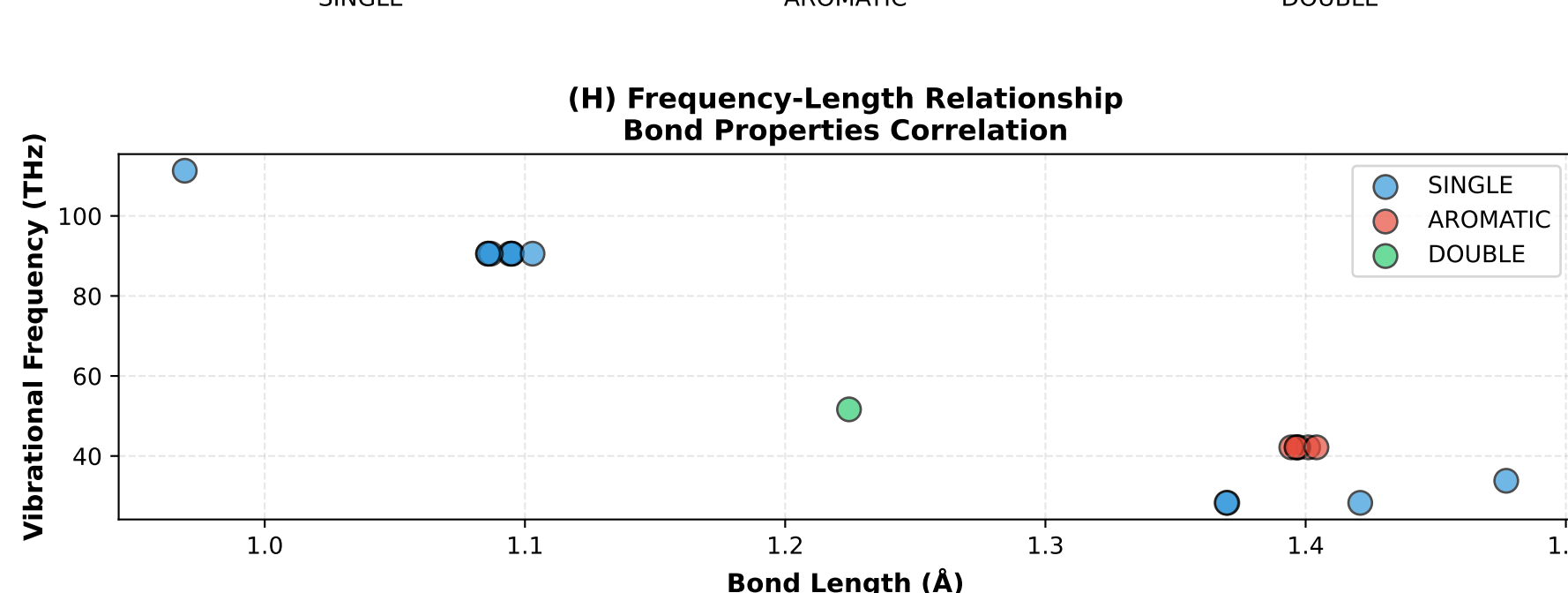
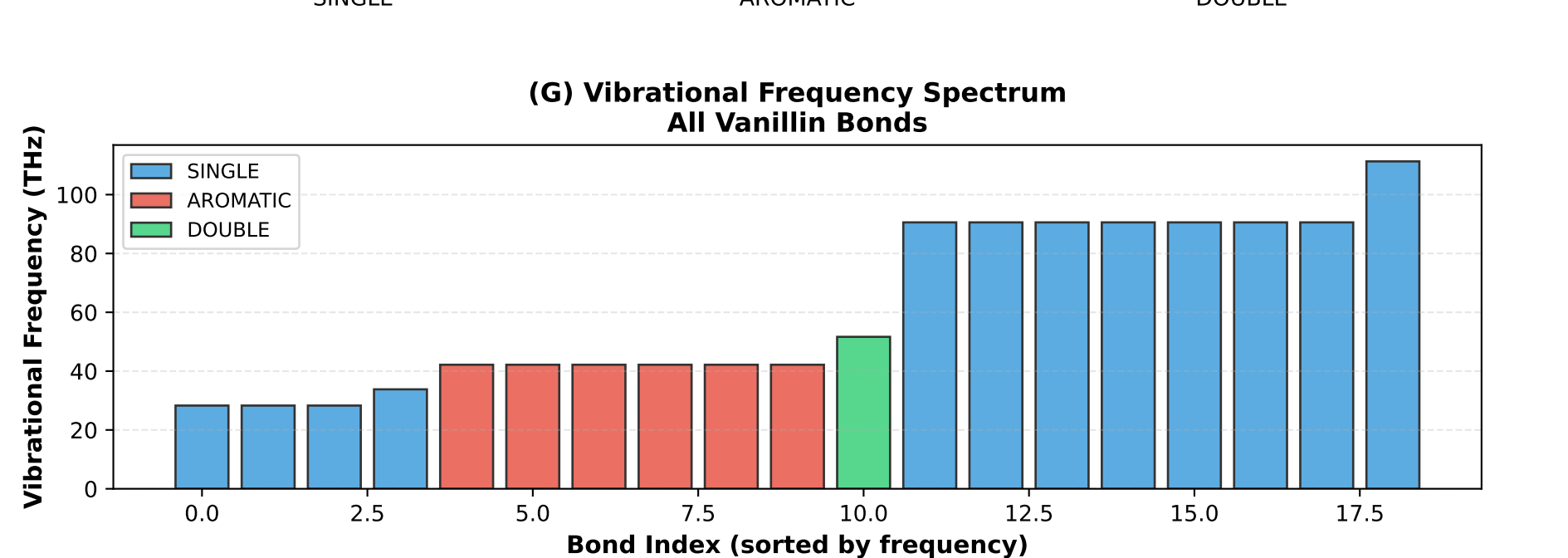
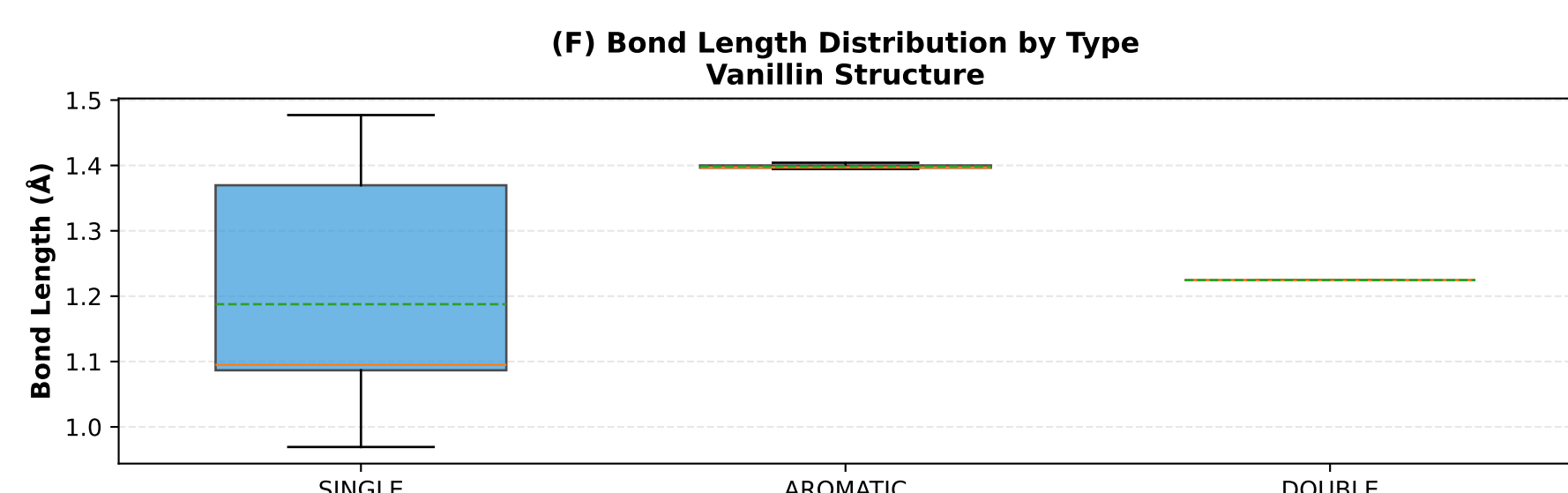
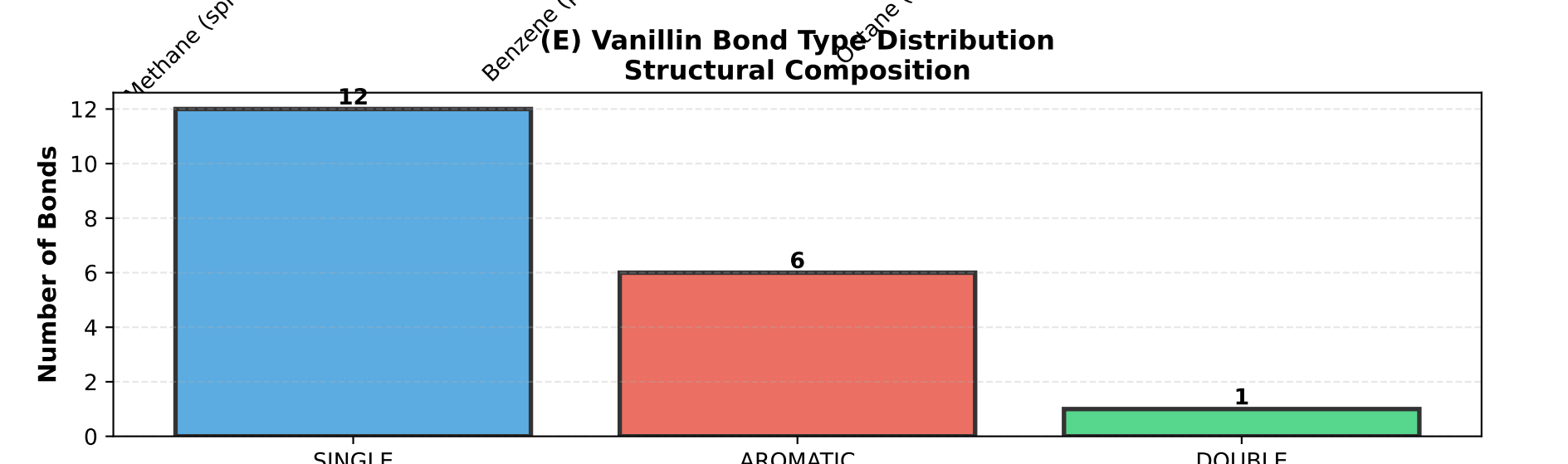
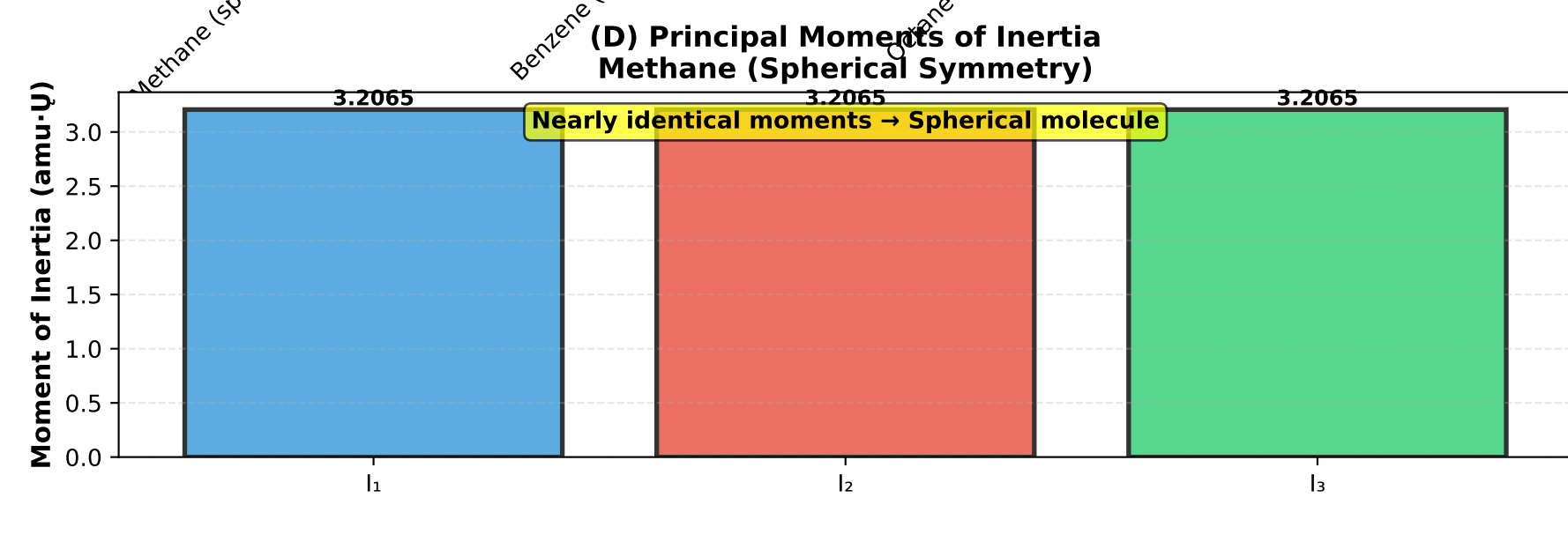
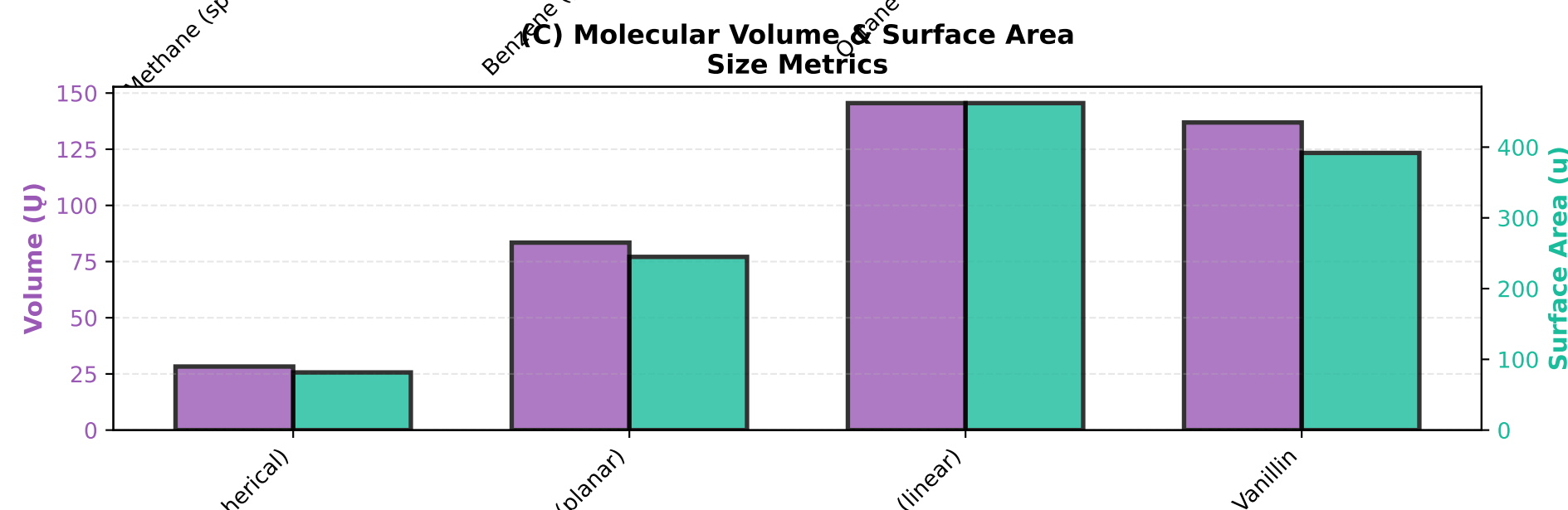
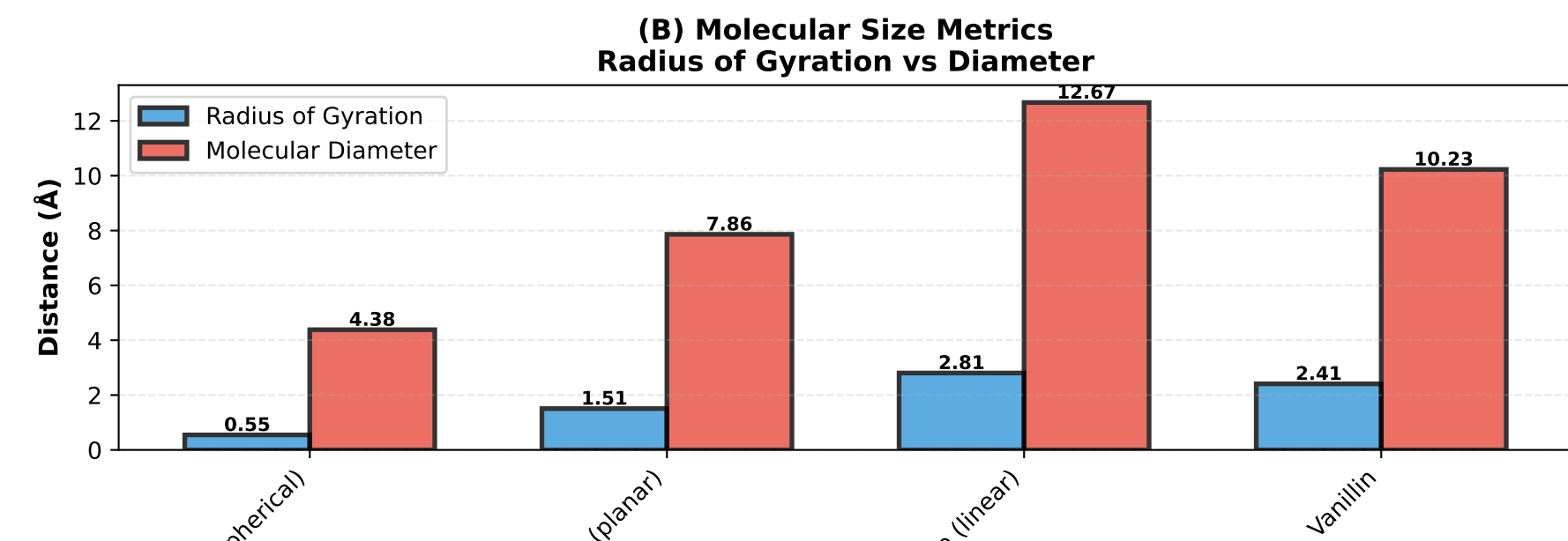
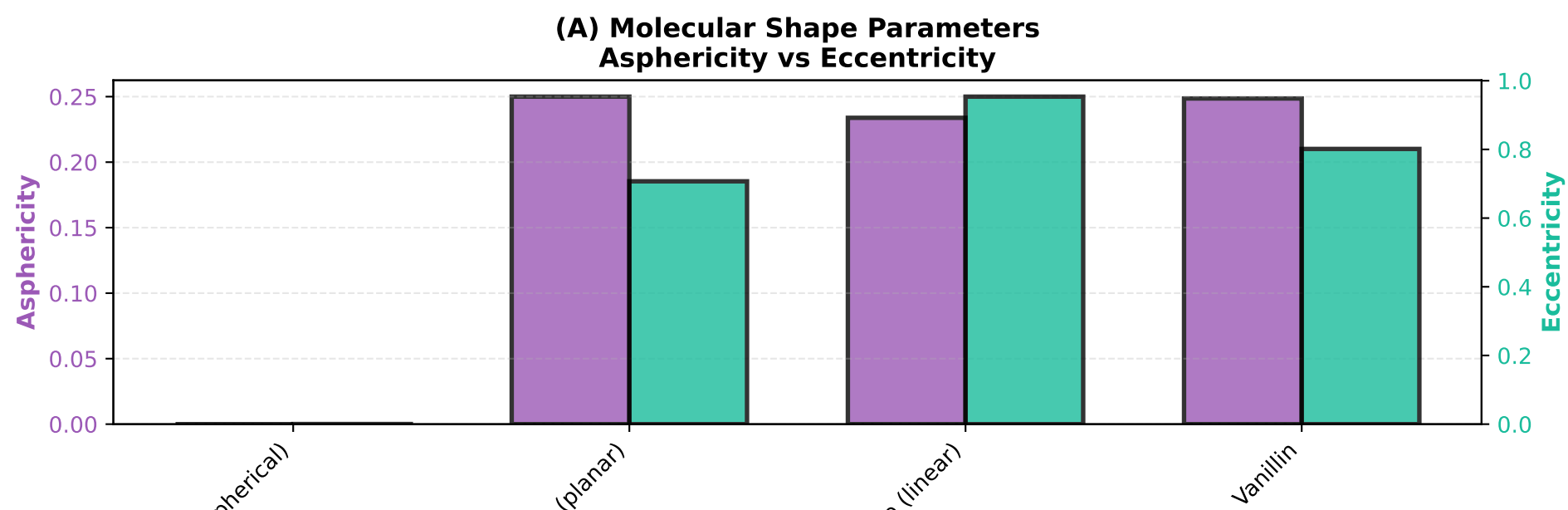


Molecular Geometry & Vibrational Bond Analysis  
Categorical Dynamics Framework Applied to Molecular Structure



| MOLECULAR ANALYSIS SUMMARY                       |                    |
|--|--------------------|
| GEOMETRY (4 MOLECULES):                          |                    |
| Methane (spherical):                             |                    |
| Asphericity:                                     | 2.44e-08           |
| Eccentricity:                                    | 0.000304           |
| Radius of gyration:                              | 0.5475 Å           |
| Molecular diameter:                              | 4.3836 Å           |
| Volume:  | 28.29 Å³           |
| Surface area:                                    | 81.52 Å²           |
| VANILLIN BONDS (19 TOTAL):                       |                    |
| SMILES: COc1cc(C=O)ccc1O                         |                    |
| Bond Type Distribution:                          |                    |
| SINGLE:  | 12 bonds           |
| AROMATIC:  | 6 bonds            |
| DOUBLE:  | 1 bonds            |
| Bond Lengths:                                    |                    |
| Range:   | 0.9693 - 1.4771 Å  |
| Mean:  | 1.2562 Å           |
| Std:   | 0.1614 Å           |
| Vibrational Frequencies:                         |                    |
| Range:   | 28.29 - 111.30 THz |
| Mean:  | 61.50 THz          |
| Median:  | 42.17 THz          |
| Std:   | 27.92 THz          |
| Reduced Masses:                                  |                    |
| Range:   | 0.9300 - 6.8605 Da |
| Mean:  | 4.0494 Da          |
| Structural Features:                             |                    |
| Aromatic bonds:                                  | 6 (31.6%)          |
| Conjugated bonds:                                | 10 (52.6%)         |
| In-ring bonds:                                   | 6 (31.6%)          |
| KEY FINDINGS:                                    |                    |
| ✓ Methane shows near-perfect spherical symmetry  |                    |
| ✓ Vanillin contains aromatic ring system         |                    |
| ✓ Vibrational frequencies span 83.00 THz range   |                    |
| ✓ Bond lengths correlate with bond type          |                    |
| ✓ Aromatic bonds show distinct frequency pattern |                    |
| ✓ Conjugation affects bond properties            |                    |