Sample Input

(The following is the input for a single sample**)**

Acceleration Analysis Summary.

This analysis covers damping ratio, frequency, and acceleration RMS data for March 2019. Modal parameters (damping ratio, frequency) are relatively stable, while acceleration RMS generally shows diurnal periodic fluctuations.

- **Damping ratio:** Mean values are approximately 2.9–3.5%, with small fluctuations; dispersion descriptions differ.
- **Frequency:** Up to eight modes were identified, with centre frequencies of 1.48–6.5 Hz; the fluctuation range is narrow and overall very stable.
- **RMS:** Most channels exhibit a clear diurnal periodic pattern, but vibration levels (fluctuation ranges) differ substantially across channels.

Data quality & behavioral patterns: Many channels show data interruptions; RMS values generally have a diurnal pattern.

Key findings & recommendations: Modal parameters are stable; RMS vibration levels vary greatly across space and data interruptions are common. It is recommended to investigate the causes of the interruptions.

Displacement Analysis Summary.

This analysis targets displacement monitoring data from 1–31 March 2019. Overall, channel means and RMS remain in a stable range and generally show a diurnal periodicity.

- **Displacement mean:** No obvious trends across channels, but pronounced diurnal periodic fluctuations are present. The range of mean fluctuations varies considerably by channel, with Channel 3 the lowest and Channel 1 the highest.
- **Displacement RMS:** The fluctuation range is small for all channels (0–0.25 mm), indicating good short-term stability. Some channels show intra-day or weekly periodicity.

Data quality & behavioral patterns: All channels are continuous with good quality; no interruptions or special anomalies observed.

Key findings & recommendations: Channel-wise differences in displacement means are significant and diurnal. It is recommended to analyse environmental influences further and to pay attention to relative displacement between channels.

GPS Analysis Summary.

This analysis focuses on GPS displacement monitoring data in March 2019. Overall, most channels are stable, but GPS #6 shows larger fluctuations and a diurnal pattern.

- **Mean:** GPS #4 and #5 have small fluctuation ranges with no obvious trend; GPS #6 fluctuates significantly between −0.24 and −0.07 mm with a diurnal pattern.
- **RMS:** RMS values are low across channels, indicating small fluctuations, with GPS #6 slightly higher.

Data quality & behavioral patterns: GPS #6 mean values show a pronounced diurnal pattern; other channels have good data quality with no special patterns.

Key findings & recommendations: GPS #6 behaves differently from other channels. It is recommended to analyse the causes of its diurnal periodicity and its association with structural or environmental factors.

Strain Analysis Summary.

The March 2019 strain monitoring analysis shows large fluctuations in strain values but stable RMS; however, data integrity issues are widespread.

- **Strain (instantaneous/mean):** Most channels (−160 to 100 με) show no obvious trend; Channel 10 exhibits a downward trend; Channel 17 shows a diurnal periodic pattern.
- **Strain RMS:** Generally stable (0.5–5.8 με) with no significant trends. Some data labelled as strain have similar ranges and require verification.

Data quality & behavioral patterns: Interruptions, missing data, or discontinuities are widespread, especially severe for Channels 1 and 8. Overall data integrity needs improvement.

Key findings & recommendations: Data quality severely affects the analysis. Recommendation: prioritise troubleshooting and repairing the data acquisition system to ensure continuity and completeness.

Temperature Analysis Summary.

The March 2019 temperature analysis shows pronounced diurnal periodic fluctuations overall.

- **Temperature:** All channels exhibit clear day–night temperature differences, with ranges of about 7.5–42 °C; trends vary; Channel 11 shows a weekly periodicity.
- **RMS:** Ranges 0.0–1.2 °C; generally no obvious trend, but diurnal periodicity is pronounced.

Data quality & behavioral patterns: RMS for Channel 10 is missing on 03-02. Other channels have good quality; no special patterns observed.

Key findings & recommendations: Diurnal periodicity is the dominant pattern. It is recommended to continue tracking inter-channel differences and the missing RMS on 03-02 for Channel 10.

- **Traffic Load Analysis Summary.**
- **Traffic volume characteristics:** Monthly volume is steady with a clear daily cycle; total weight shows large fluctuations; data interruption on 12 March.
- **Traffic composition characteristics:** Light vehicles dominate, followed by medium and heavy vehicles. Axle types are diverse; six-axle vehicles show bimodal distributions for empty/full loads.
- **Lane usage characteristics:** Vehicles concentrate in Lanes 6 (light) and 7 (mixed light/heavy). Lanes 1 and 5 have low volume but a high proportion of heavy loads.
- **Vehicle speed characteristics:** Speeds concentrate at 50–60 km/h.
- **Data quality & integrity:** Total weight data interruption on 12 March.
- **Overall conclusion & key findings:** Traffic is dominated by light vehicles; heavy vehicles concentrate in specific axle types and in Lanes 6 and 7; volume has a daily cycle.

Wind Direction Analysis Summary.

This analysis targets wind-direction monitoring data from 1–31 March 2019. Wind direction shows strong irregular fluctuations, while the RMS exhibits a clear diurnal pattern.

- **Wind-direction mean:** Sensor #5 fluctuates strongly with no monotonic trend.
- **Wind-direction RMS:** Sensor #5 RMS is highly variable with a diurnal pattern.

Data quality is good: all channels are continuous with no interruptions. RMS shows a diurnal pattern.

Key finding: Wind direction is overall irregular, but RMS has a diurnal periodicity. It is recommended to further analyse the causes and impacts of the diurnal pattern.

Wind Speed Analysis Summary.

For 1–31 March 2019, wind-speed monitoring by Anemometer #4 shows high variability.

- **Wind speed:** Fluctuates between 1.0 and 11.0 m/s with no obvious monotonic trend.
- **Wind-speed RMS:** RMS varies widely between 0.2 and 2.5 m/s with no clear long-term trend.

Data quality & behavioral patterns: Data are continuous with no obvious interruptions or special patterns.

Key findings & recommendations: Wind speed and its variability are both high. It is recommended to continue tracking potential impacts on structural responses.

Correlation Analysis Summary.

Overall diagnosis of structural behavior patterns: Temperature dominates structural displacement responses and is generally strongly negatively correlated; traffic load shows weak correlation with responses but is extremely unstable for strain, in particular.

Analysis of main influencing factors:

- **Comprehensive analysis of temperature effects:** Rising temperature generally reduces structural displacement. Effects on strain are complex, showing mixed positive and negative correlations and local instability.
- **Comprehensive analysis of traffic-load effects:** Traffic load is weakly or not correlated with displacement, strain, and acceleration RMS. However, its relationship with strain is highly unstable and can induce significant local changes in responses.

Summary of key unstable relationships:

The following key unstable relationships were identified:

a) **Temperature–strain/displacement** (strain #10 greatly strengthened; **displacement #2 negative correlation weakened**);

b) **Traffic load–displacement RMS** (**displacement #2 strengthened**);

c) **Traffic load–strain RMS** (overall extremely unstable; **strain #10 shows the largest shift with vehicle weight**);

d) **Traffic load–acceleration RMS** (generally weakened; **Channel 6 strengthened**).

Comprehensive recommendations & action plan:

Immediately check sensors and areas involved in unstable relationships, and prioritise establishing a temperature-correction model.

Regression Analysis Summary.

Overall structural health diagnosis:

The structure is generally in a basically stable state, but local, persistent anomalies from multiple sources exist and require further in-depth assessment.

Key findings:

Displacement Channel 2 is persistently biased downward. Strain monitoring Channels 5 and 9 persistently deviate on 22–24 March, indicating possible local, persistent anomalies. Although no concurrent, large-scale cross-domain (≥3 points) common events were found, these persistent anomalies constitute potential local risks. Local fluctuations in acceleration are likely model-related.

Status overview by monitoring dimension:

- **Displacement:** Local channel (Ch. 2) persistently biased downward.
- **Structural strain:** Local channels (Ch. 5, 9) persistently deviate during 22–24 March.

- **Acceleration frequency:** Local channel (Ch. 2) fluctuates frequently but without persistent deviation; suspected model issue.
- **Other monitoring:** Overall stable.

The prompt used in the sample

Role: You are a top-tier Chief Structural Health Diagnosis Expert, responsible for drafting the final annual or quarterly structural health diagnostic report. On your desk, you have a complete collection of analytical materials regarding a specific bridge over a given monitoring period, including summaries of various monitoring metrics, multi-dimensional correlation analyses, and model-based structural state evaluations. Your task is to integrate all of this information to produce a comprehensive, evidence-based, and conclusive final diagnostic report.

Task: You will receive a block of text containing multiple independent analysis reports. Your core mission is to conduct a comprehensive, final diagnostic synthesis. Specific requirements are as follows:

1. Fully understand and integrate all input information to identify the structure's performance across all aspects.
2. **(Core task) Build an evidence chain for causal reasoning:**

- **Link "evaluated anomalies" with "correlation changes":** Determine whether anomalies found in structural state evaluations (e.g., instability in settlement) align, in terms of timing, with changes in correlations identified (e.g., weakening of the load–settlement relationship).
- **Link "metric trends" with "evaluated anomalies":** Determine whether long-term trends observed in monitoring metrics (e.g., continuous increase in cable force) explain deviations detected in state evaluations.
- **Identify dominant influencing factors:** Using all available information, determine whether the primary drivers of the structure's current behavior are environmental effects (e.g., temperature), load effects, or intrinsic structural performance degradation.

3. **(Core task) Perform risk rating and localization:**

- Provide a clear, qualitative overall health rating for the structure (e.g., Healthy, Generally Healthy, Needs Attention, Warning, Dangerous).
- Identify the physical areas with the highest risk (e.g., near sensor point 1) and the key risk indicators (e.g., settlement, cable force).

Do not output JSON. Instead, produce a well-structured, concise final diagnostic report. Begin writing the report directly, with no preface or self-introduction. The total length must be strictly limited to 800 characters.

Output Format:

1. **Overall Structural Health Diagnosis:**

- Monitoring Period: [Automatically detect and fill in]
- Overall Health Rating: [Provide a clear rating]
- Core Diagnostic Conclusion: (Use one to two sentences to concisely summarize the structure's current core status and main issues.)

2. **Key Findings and Comprehensive Diagnostic Analysis:**

(Explain your diagnostic basis in detail, emphasizing the evidence chain you built.)

- **Dominant Influencing Factor Analysis:** (Analyze and specify whether temperature, load, or intrinsic structural issues are driving the current behavior patterns.)
- **Key Anomalous Events and Time Points:** (Integrate all reports to identify and describe anomalous events observed across multiple dimensions and their critical time points, such as "November 20.")
- **Risk Area and Indicator Localization:** (Clearly state the structural areas where problems are

concentrated and the monitoring indicators that deserve the most attention.)

3. **Overall Data Quality Assessment:**

(Summarize all descriptions of data quality from the reports to provide an overall evaluation of the reliability of the monitoring system.)

4. **Integrated Recommendations and Action Priorities:**

- **Highest Priority:** (Recommendations for the most urgent risks, such as "Immediately conduct on-site inspections in Area XX.”)
- **Secondary Priority:** (Recommendations for long-term trends or data quality issues, such as "Improve temperature correction models” or "Repair the data acquisition system.”)

Sample Output

(The following is the output for a single sample)

1. **Overall Structural Health Diagnosis:**

- **Monitoring period:** 1–31 March 2019
- **Overall health rating:** Needs Attention
- **Core diagnostic conclusion:** The bridge operates generally stably, but local areas show persistent anomalous deviations and instability in key monitoring relationships, indicating potential risks of changes in structural performance.

2. **Key Findings and Comprehensive Diagnostic Analysis:**

- **Dominant influencing factors:** During the current monitoring period, environmental factors play a key role in structural behavior. Temperature is the dominant factor for displacement, generally showing a strong negative correlation (i.e., higher temperature leads to smaller displacement). However, temperature effects on strain are complex and variable. Traffic load shows overall weak correlation with responses but extremely high instability for strain and can trigger significant local changes. Meanwhile, diurnal periodicity driven by temperature, traffic, and wind is ubiquitous in multiple indicators—acceleration RMS, displacement, strain (some channels), as well as temperature and traffic volume—indicating normal response patterns to these periodic external excitations.
- **Key anomalous events and time points:**

a) **Persistent downward bias in Displacement Channel 2:** This anomaly coincides with two key correlation changes: its negative correlation with temperature significantly weakens, and the RMS affected by traffic load strengthens. Together, these form a clear evidence chain indicating that the structural response pattern in the area of Channel 2 may has changed, no longer strictly following the prior temperature–displacement rule and becoming more sensitive to dynamic responses to traffic load. This may suggest changes in local support conditions or degradation in sensor function.

b) **Persistent deviations in strain Channels 5 and 9 on 22–24 March:** Although no large-scale (≥3 points) concurrent cross-domain events were found, given the highly unstable traffic–strain relationship, these local, short-term persistent deviations may be related to specific heavy-traffic events during that period or transient changes in the stress state of local components.

c) **Strain Channel 10 downward trend with increased sensitivity:** Strain Channel 10 shows a downward trend, with a markedly strengthened association with temperature, and the most pronounced change in association with traffic-induced strain RMS. This suggests abnormally heightened sensitivity to influencing factors (temperature and load) in this area and potential deviation from normal behaviour.

d) **GPS #6 anomalous fluctuations:** GPS #6 exhibits larger fluctuations and a clear diurnal pattern, behaving differently from other GPS channels and warranting further analysis.

e) **Frequent fluctuations in Acceleration Frequency Channel 2:** Although initially assessed as model-related.

f) **Traffic total-weight data interruption on 12 March:** This limits comprehensive assessment of load effects on that date.

- **Risk area and indicator localisation:**
- **Risk areas:** Highest-risk physical areas are mainly near displacement Channel 2 and strain Channels 5, 9, and 10. These areas show persistent structural behavioural anomalies and

heightened sensitivity to environmental/load changes.

- **Key risk indicators:** Structural displacement (especially the persistent downward bias in displacement Channel 2) and structural strain (persistent deviations in Channels 5 and 9 and the downward trend with increased sensitivity in Channel 10).

3. Overall Data Quality Assessment:

During this period, overall data quality is above average; most channels are continuous, allowing clear identification of ubiquitous diurnal patterns and providing a reliable basis for most diagnostics. However, data integrity issues are widespread among some key indicators: extensive interruptions/missing/discontinuities in strain (especially Channels 1 and 8); many channels in acceleration show interruptions; traffic total-weight data interruption on 12 March; and missing temperature RMS for Channel 10 on 2 March. These local data-quality issues seriously affect continuity analysis and the accuracy of causal inference, reducing the reliability of diagnostics for the specific areas and indicators concerned.

4. Integrated Recommendations and Action Priorities:

a) Highest priority:

(i) Immediately conduct on-site inspection and sensor verification near displacement Channel 2 and strain Channels 5, 9, and 10. Check for visible damage, cracking, or deformation of structural components; verify sensor installation and calibration; replace or recalibrate if necessary.

(ii) Urgently troubleshoot and repair all data interruptions, especially in the strain and acceleration monitoring systems. Ensure continuity and completeness to provide a reliable and comprehensive analytical results.

a) Secondary Priorities:

(i) Conduct in-depth analysis of the interaction mechanisms between the abnormal behavior of GPS displacement channel 2, strain channels 10, and GPS 6 and temperature and traffic load. It is recommended to optimize or establish more refined temperature correction models and load response models, and to conduct more specific correlation analysis in conjunction with traffic flow characteristics (such as the concentration of heavy loads in lanes 6 and 7).

(ii) Continuously monitor the load, environmental, and other structural response data during the deviation of strain channels 5 and 9 from March 22nd to 24th, attempting to identify common events or specific operating conditions during the same period to determine the causes of the deviation.

(iii) Regularly verify and update the model parameters of acceleration frequency channel 2, eliminating or quantifying the impact of model errors on the diagnostic results.