Surface plate flatness inspection plan

surface-plate-flatness

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Application template; not a claim of a completed customer project.

Scope

For macroscopic plates, tables and mounting surfaces. Slope integration and direct height measurements require different data inputs.

Equipment and configuration guidance

• Angular or height system matched to area and tolerance

• Defined supports and sampling grid

• Shared nodes, closure checks and environment records

Principle and calculation

Slope readings require integration and a common reference across lines. Direct heights use point coordinates. Least-squares plane residual peak-to-valley must not be labelled minimum-zone flatness.

On-site checklist

• Supports remain unchanged

• Lines share one height reference

• Sampling covers critical regions

Suggested records

• Grid and raw data

• Surface map and closure checks

• Method, result and sampling limitations

Limitations

Sparse sampling may miss local defects. This plan does not replace optical interferometry or roughness measurement.

Detailed teaching example

3×3 table grid: teaching surface form after removing overall tilt

Scenario and task

Teaching demonstration, not a real customer project. Nine direct-height points on a 200 mm×200 mm area illustrate least-squares plane fitting. They already share one height datum; this is a direct-height model, not angular readings treated as heights. A sparse teaching grid cannot establish complete table acceptance.

Workflow overview

Define measurement model → Set nine-point grid → Acquire common-datum heights → Fit plane and residuals → Show sampling limits → Deliver model and data

Preparation and measurement steps

01. Define coordinates, useful area, supports and direct-height measurement. The nine-point grid is illustrative; actual density must reflect the risk of local surface features.

02. Set nodes where x and y each equal 0, 100 or 200 mm, record a common height reference and keep supports unchanged.

03. Acquire all nine heights while rechecking one fixed reference. Multi-line systems must unify datums before producing this type of height matrix.

04. Fit the least-squares plane z=ax+by+c and subtract its height at each node to obtain nine signed residuals.

05. Plot the grid and residual map, identify extreme points and unsampled regions; do not invent measured detail between nodes.

06. Deliver raw coordinates, fitted coefficients, residuals, algorithm, coverage limits and uncertainty. Use a separate appropriate evaluation if the contract requires minimum-zone flatness.

Teaching example readings

• Coordinates x and y each take 0, 100 and 200 mm.

• Height rows at y=0, 100, 200 mm (μm): [1,−1,3]; [0,7,2]; [5,3,7].

• All heights are synthetic and already share a datum.

Calculation procedure

The least-squares plane is z=0.01x+0.02y+0, with z in μm and x,y in mm. Residual rows are [1,−2,1]; [−2,4,−2]; [1,−2,1] μm. Their mean and first moments with x and y are zero. Sampled residual peak-to-valley=4−(−2)=6 μm.

Example result and interpretation

The nine-point residual peak-to-valley relative to the least-squares plane is 6 μm. It is a result for this algorithm and grid, not automatically minimum-zone flatness or proof that unsampled regions are defect-free.

Example verification checklist

• All points must share one height datum; independently zeroed rows cannot simply be stitched together.

• Support and load changes can alter form; retain the prescribed and documented state.

• Surface form, surface roughness and optical wavefront quality are separate tasks.

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