WHAT IS CLAIMED IS:

1. A tunnel boring machine comprising:

a cutter head (11);

a cutter head support (12) supporting the cutter head and configured to rotate with the cutter head;

a cutter driving unit (14) configured to rotationally drive the cutter head and the cutter head support;

a rotational position sensing unit (20) configured to sense a position of the cutter head in a rotational direction;

at least one strain sensor (22) provided in a cutter spoke itself of the cutter head; and

a data processing unit (23, 123, 223) configured to calculate a force acting on the cutter head in association with the position of the cutter head in the rotational direction, based on sensing results of the strain sensor and the rotational position sensing unit.

2. A tunnel boring machine having an intermediate support structure, comprising:

a cutter head (11);

a cutter column (12), which is a cutter head support (12) supporting the cutter head and configured to rotate with the cutter head;

a cutter driving unit (14) configured to rotationally drive the cutter head and the cutter head support;

a rotational position sensing unit (20) configured to sense a position of the cutter head in a rotational direction;

at least one strain sensor (22) provided in the cutter column (12); and

a data processing unit (23, 123, 223) configured to calculate a force acting on the cutter head in association with the position of the cutter head in the rotational direction, based on sensing results of the at least one strain sensor and the rotational position sensing unit.

wherein the cutter column (12) is configured to move in a circumferential direction, has a rectangular tube shape, and includes a pair of side surfaces facing the circumferential direction, and the strain sensor (22) is mounted to each of a pair of installation surfaces (12a, 113, 213), using inner surfaces of the pair of side surfaces facing the circumferential direction as the pair of installation surfaces.

3. The tunnel boring machine of claim 1 or 2 wherein the data processing unit is configured to calculate rotational direction distribution of forces acting on the cutter head in a direction of a rotation axis, based on sensing results of the at least one strain sensor and the rotational position sensing unit.

4. The tunnel boring machine of claim 1 wherein the at least one strain sensor comprises three or more strain sensors arranged in the cutter spoke itself at regular angular intervals.

5. The tunnel boring machine of claim 1 or 2, further comprising a temperature sensor (25) provided near the at least one strain sensor,

wherein the data processing device is configured to perform temperature compensation on the sensing results of the at least one strain sensor, based on a temperatures near the at least one strain sensor sensed by the temperature sensor.

6. The tunnel boring machine of claim 1 wherein the at least one strain sensor is mounted to installation surfaces (213) of the cutter spoke itself, the installation surfaces being substantially in parallel with the rotation axis of the cutter head.

7. The tunnel boring machine of claim 1, wherein

the cutter head includes the cutter spoke (11b) extending in a radial direction,

the at least one strain sensor is provided in installation surfaces of the cutter spoke itself of the cutter head, the installation surfaces being substantially parallel to the rotation axis, and

the data processing unit is configured to calculate rotational direction distribution of forces acting on the spoke in a rotational direction, based on the sensing results of the at least one strain sensor and the rotational position sensing unit.

8. The tunnel boring machine of claim 2 wherein the at least one strain sensor comprises three or more strain sensors arranged in the cutter column at regular angular intervals.

9. The tunnel boring machine of claim 8 wherein the at least one strain sensor is mounted to installation surfaces (12a) of the cutter column, the installation surfaces being substantially in parallel with the rotation axis of the cutter head.