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III

Shake down Tests on Steel Beams with Distributed Loads

Essais de shake down sur poutres en acier avec charge répartie

Shake-down-Versuche an Stahlbalken mit verteilter Last

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Introduction

At Chalmers University of Technology a number of shake down tests have been made on continuous two and three span rolled steel beams.

Testing procedure

The loading scheme of the two span beams is shown in fig.1. The load control and the registration of strain and deflection were arranged to be automatical. In fig.2 the load versus time relationship is shown. The period of a complete load cycle was chosen to either 5 or 10 minutes. For some beams recently tested a cycle period of 20 minutes was used.

The distributed loads were simulated by several (6 or 9) hydraulic jacks per span. Three beams with one or two concentrated loads per span have also been tested.

The span length of the tested beams was 2, 3 and 4 m. The test beams were of European standard HE 100 A, HE 100 B (wide flange beams with about 100 mm depth) and HE 160 A, HE 160 B (wide flange beams with about 160 mm depth). Four beams (no.21-24) were made of two parts (HE 100 A and HE 100 B) butt jointed 0,5 m from the central support. Further data are found in table 1 together with calculated and measured shake down loads.

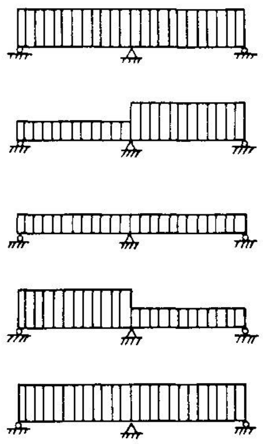

Fig.1 Loading scheme for the two span beams

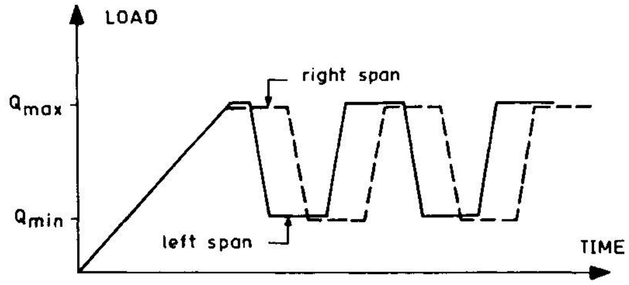

Fig.2. Load versus time relationship

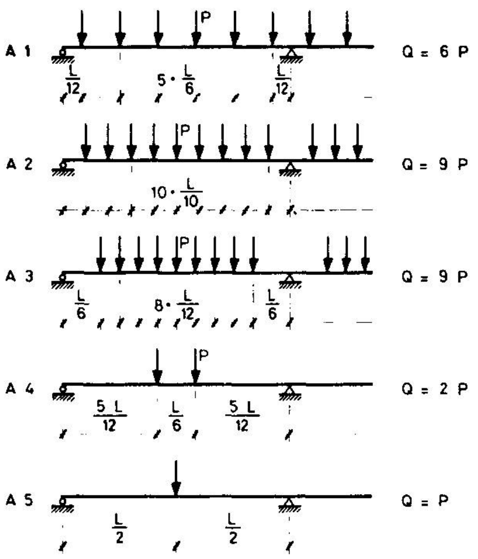

Fig.3 Placing of the hydraulic jacks, cf tab.1

In fig.4 and 5 some test results are shown. The first diagram shows for a two span beam the measured strain at the central support versus cycle number and the second diagram shows measured midspan deflections of both spans. This beam was retested four weeks later and the measured strain at the central support is shown in fig.5. Notice that in this second test of the same beam greater loads are needed in order to get permanent deflections. Further results are shown in fig.6 (beam 24). The tendency of stabilization is very clear.

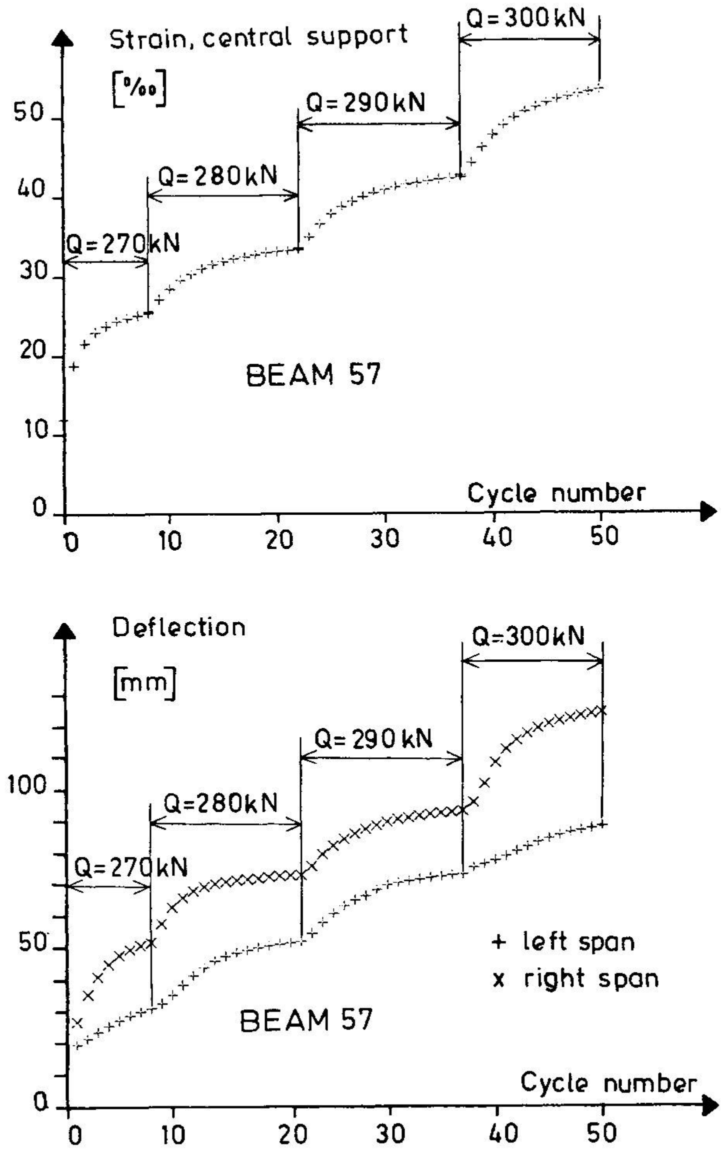

Fig.4 Measured strain at the central support and measured midspan deflections versus cycle number. Beam 57.

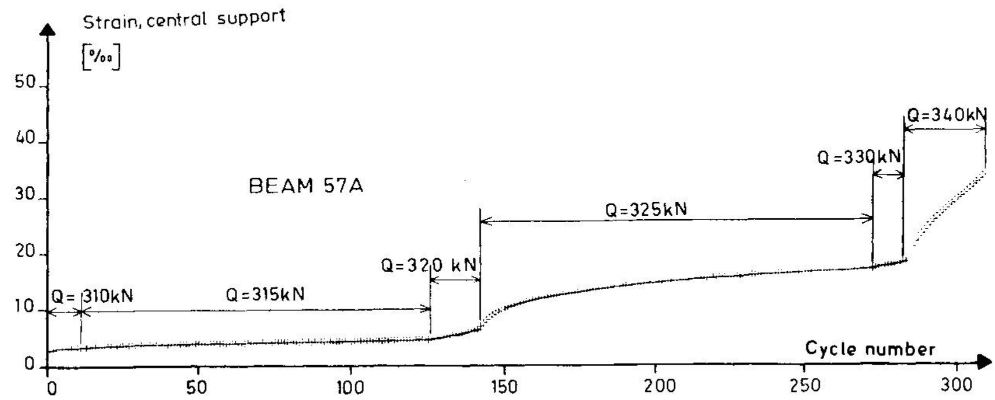

Fig.5 Measured strain at the central support versus cycle number. Beam 57 A.

Test results

The tests are not yet fully evaluated, but some results will be given below.

1. Due to strain hardening the measured shake down loads are about 15 % greater than the calculated loads.
   In the tests the shake down loads were found to be almost equal to the calculated plastic loads without regard to shake down.

2. The shake down behaviour is time dependent. To reach a stable behaviour a greater number of load cycles were needed when the time per load cycle was short than when the cycle time was long.
   Further, if the beam is allowed to rest for some time (a rest of four weeks or more has been tested), the shake down load of the retested beam will be greater than at the first test.

3. A few cycles of overloading have a reinforcing effect. Let Q_s denote the shake down load determined with increasing load levels in the ordinary testing procedure. If the structure then is subjected to some load cycles with a load greater than Q_s, this will accelerate the stabilization process when the beam is again subjected to the load Q_s.

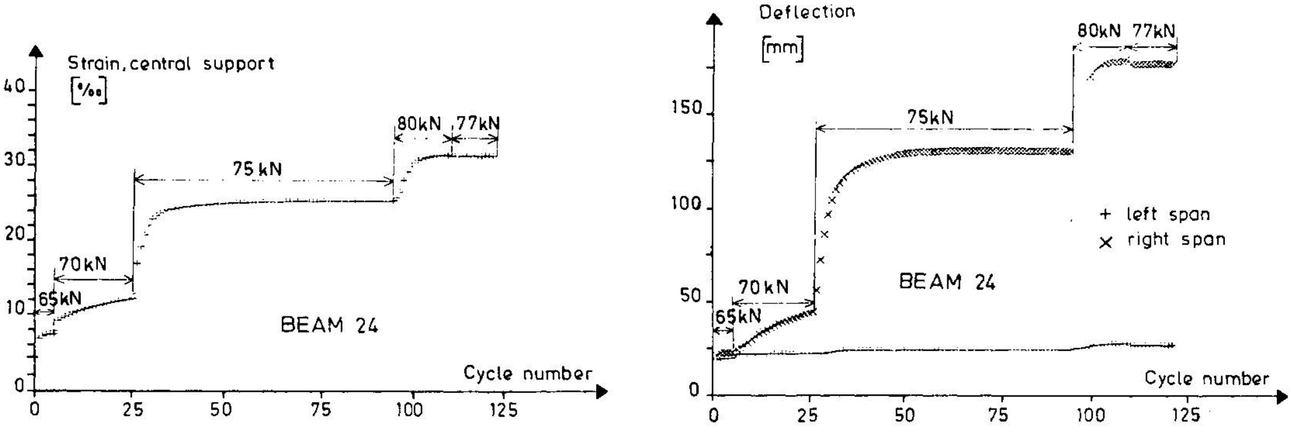

Fig. 6. Measured strain at the central support and measured midspan deflections versus cycle number. Beam 24.

Tab.1 Two span beams

Beam no.	Span length m	Beam	Minutes per cycle	Total number of cycles	Loads (kN) Minimum load	Q_s^{calc}	Q_s^{meas}
21	3,0	HE100A, B	5	47	30	75	85
22	3,0	HE100A, B	5	35	30	80	> 90
23	3,0	HE100A, B	10	381	15	72	92
24	3,0	HE100A, B	10	121	15	65	80
31	2,0	HE100A	5	85	45	108	135
33	2,0	HE100B	5	95	55	121	150
35	2,0	HE100B weak axis	5	52	30	64	> 80
41	3,0	HE100A	10	32	30	67	> 80
43	3,0	HE100B	10	49	40	95	> 110
44	3,0	HE100B	10	215	20	90	90
45	3,0	HE100A	10	135	15	65	77
52	4,0	HE160A	10	22	60	158	170
53	4,0	HE160B	10	44	80	204	230
55	3,0	HE160A	10	42	30	151	> 175
56	3,0	HE160A	5	73	30	151	175
57	3,0	HE160B	10	50	50	258	> 300
57A	3,0	HE160B	10	309	50	258	320
58	3,0	HE160B	5	67	50	258	> 300
61	3,0	HE160A	5	48	$Q_{max}/3$	130	> 160
63	3,0	HE160B	5	75	$Q_{max}/3$	183	210
72	3,0	HE160B	5	112	$Q_{max}/3$	187	215

SUMMARY

Some results from shake down tests on steel beams are given. The shake down loads were found to be approximately 15% greater than the calculated loads. Further, the time dependence and the effect of an overload are discussed.

RESUME

On donne quelques résultats d'essai du "Shake down" sur des poutres en acier. Les charges du Shake down s'avéraient de 15% supérieures aux charges calculées. On discute en outre la dépendance du temps et l'effet d'une surcharge.

ZUSAMMENFASSUNG

Es werden einige Ergebnisse von "Shake-down"-Tests an Stahlbalken mitgeteilt. Die Shake-down-Belastungen erwiesen sich als ungefähr 15% höher als die berechneten Belastungen. Ferner werden die Zeitabhängigkeit und die Wirkung einer Ueberlast diskutiert.

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