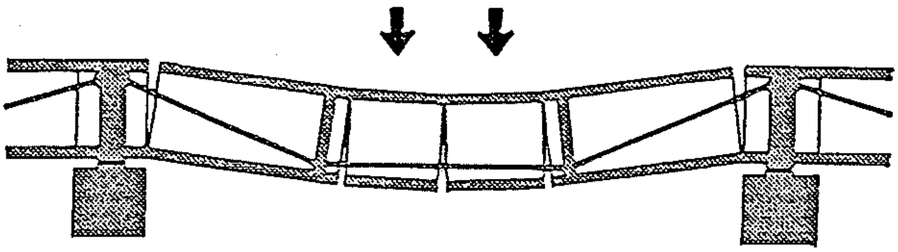
ASSOCIATION FRANCAISE
POUR LA CONSTRUCTION

WORKSHOP - SEMINAIRE

BEHAVIOUR OF EXTERNAL PRESTRESSING IN STRUCTURES
COMPORTEMENT DES STRUCTURES A PRECONTRAINTE EXTERIEURE

Saint-Rémy-Lès-Chevreuse, France
June 9-12, 1993

SYNTHESIS OF THE CALCULATION TESTS



Organized by :	AFPC	Association Française Pour la Construction
Co-sponsored by :	ACI	American Concrete Institute
	ASBI	American Segmental Bridge Institute
	CEB	Comité Euro-International du Béton
	FIP	Fédération Internationale de la Précontrainte
	PTI	Post-Tensioning Institute

With the support of :

CEBTP
Centre Expérimental de Recherches et d'Etudes du Bâtiment et des Travaux Publics

LCPC
Laboratoire Central des Ponts et Chaussées

SETRA C.T.O.A.
Service d'Etudes Techniques des Routes et Autoroutes

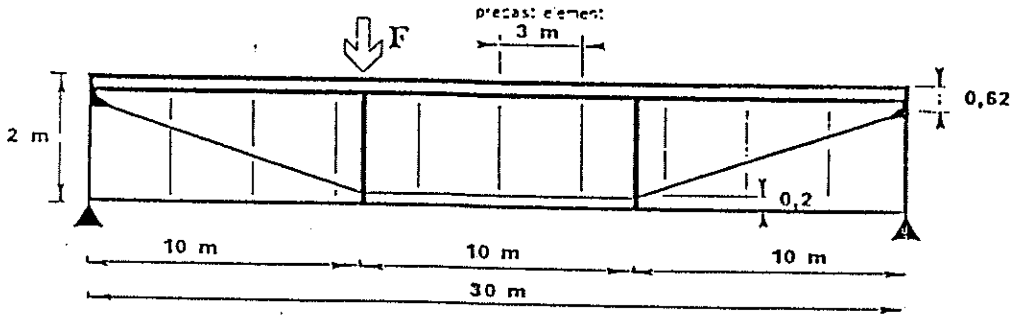
NON LINEAR CALCULATION OF A STATICALLY DETERMINATE PRESTRESSED BEAM

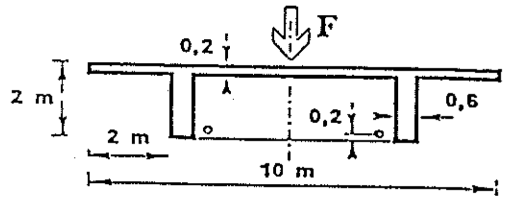
CALCULATION FORM

In view of comparison of various design methods

DATAS

Geometrical characteristics of the model :





Area : $S = 4,16\ m^2$
Distance of gravity centre to the upper fibre : $V = 0,619\ m$
Distance of gravity centre to the lower fibre : $V' = 1,381\ m$
Inertia : $I = 1,63\ m^4$

Mode of beam fabrication :

Two cases are distinguished :

* cast-in-place beam
* precast beam (joint arrangement shown on the above sketch)

Type of prestressing :

Three cases are distinguished :

* with 100 % of external prestressing
* with 100 % of internal prestressing
* with 50 % of external prestressing and 50 % internal

Prestressing characteristics :

The beam is prestressed by means of a couple of tendons having the following characteristics (for each tendon) :

* nomina area : $A_p = 5000\ mm^2$
* uniform tension in tendon after losses : $P = 6000\ kN$

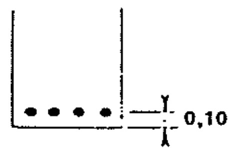
Tension increases (under F loading) will be evaluated according to one of the two following assumptions :

* no *slip* at deviators
* free *slip* at deviators

(any intermediate figure may be examined)

Reinforcing steel :

They are located in the bottom of the cross-section



Area per beam : $A_s = 2000\ mm^2$
(two beams)

Loads :

The beam is built in one phase on scaffolding then prestressed.

The loads are :

* self-weight of current parts (without cross-girders and deviators)
  Linear density :
  $\mu = 25\ kN/m3$ or $104\ kN/m$
* prestressing : see above
* vertical variable load F applied in a deviator cross-section
* shrinkage and creep negleged

It's asked to determine the beam deflection under

AFPC

WORKSHOP

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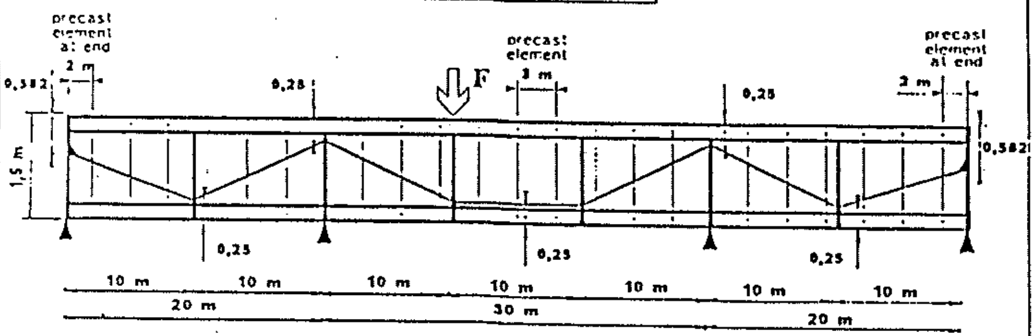
NON LINEAR CALCULATION OF A NON STATICALLY DETERMINATE PRESTRESSED BEAM

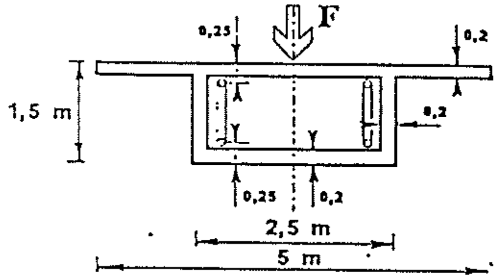
CALCULATION FORM

In view of comparison of various design methods

DATAS

Geometrical characteristics of the model :





Area : $S = 1{,}94\ m^2$

Distance of gravity centre to the upper fibre : $V = 0{,}582\ m$

Distance of gravity centre to the lower fibre : $V' = 0{,}918\ m$

Inertia : $I = 0{,}629\ m^4$

Mode of beam fabrication :

Two cases are distinguished :

* cast-in-place beam
* precast beam (joint arrangement shown on the above sketch)

Type of prestressing :

* with 100 % of external prestressing
* with 100 % of internal prestressing
* with 50 % of external prestressing and 50 % internal

Prestressing characteristics :

The beam is prestressed by means of a couple of tendons having the following characteristics (for each tendon) :

* nomina area : $A_p = 2250\ mm^2$
* uniform tension in tendon after losses : $P = 3000\ kN$

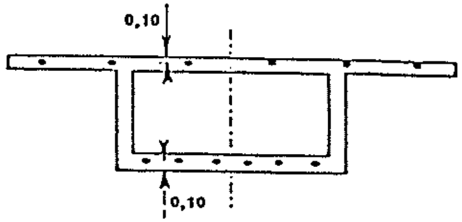
Tension increases (under F loading) will be evaluated according to one of the two following assumptions :

* no *slip* at deviators
* free *slip* at deviators

(any intermediate figure may be examined)

Reinforcing steel :

They are located in the top and in the bottom of the cross-section



Upper steels :

$A_s = 3000\ mm^2$

Lower steels :

$A_s = 4000\ mm^2$

Loads :

The beam is assumed cast-in-place in one phase on scaffolding then prestressed.

The loads are :

* self-weight of current parts (without cross-girders and deviators)

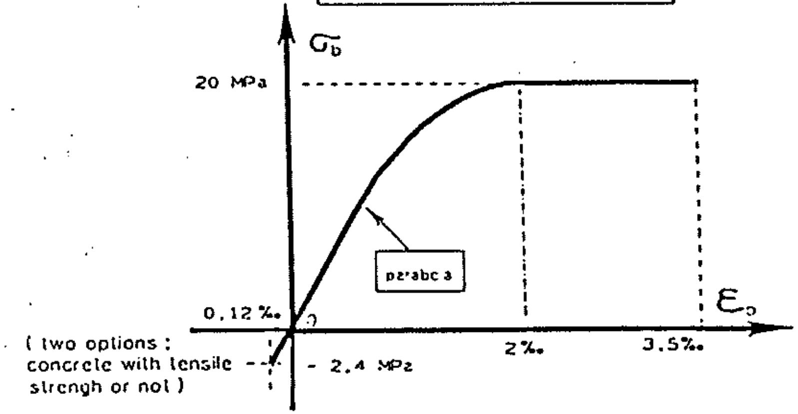
  Linear density : $\mu = 25\ kN/m3$ or $48{,}5\ kN/m$

* prestressing : see above
* vertical variable load F applied in a deviator cross-section
* shrinkage and creep negleged

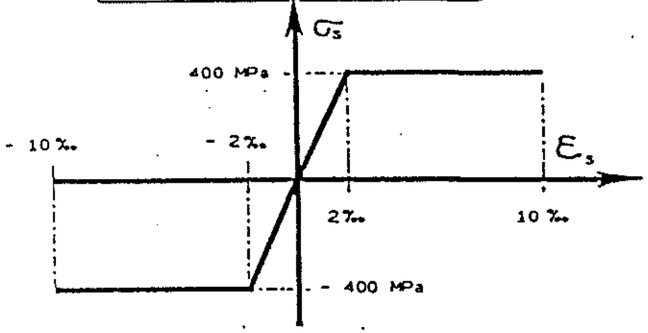
It's asked to determine the beam deflection under

Material characteristics :

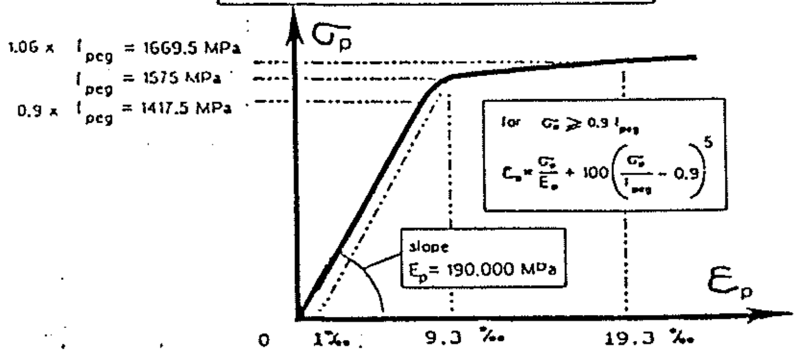
CONCRETE
parabolic-rectangular law



REINFORCING STEEL
elastic-plastic law



PRESTRESSING STEEL
strand type



CALCULATION RESULTS

You are asked to provide :

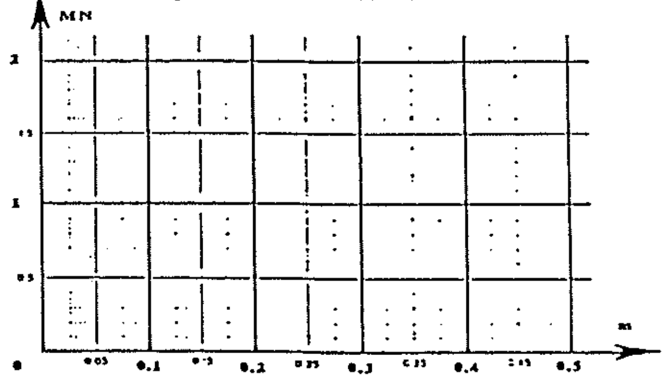
* the enclosed form filled with information of the source of calculation and the adopted data.

* a calculation note with the in-put and out-put computing sheets for several calculations.

* and to make the process easier, diagrams load-deflections (at mid-span)

for instance :

diagrams " load-deflection "



The results are to be returned to :

Mr Eric CONTI
SETRA - CTOA
46, avenue Aristide Briand
BP 100
92223 BAGNEUX CEDEX FRANCE

Telecopy : (33) 1.46.11.31.69

before April 15, 1993

Num.	Authors	Adress	Computing programm
1	Prof. KONIG QIAN	Technische Hochschule Darmstadt Germany	FEMAS
2	F. J. ULM V. MAGNAT	Laboratoire Central des Ponts et Chaussées France	CESAR
3	Prof. J. SCHLAICH T. KUCHLER	Universität Stuttgart Germany	
4	Dr. J.-M. FRANSSEN	Université de Liège Belgium	SAFIR
5	T. I. CAMPBELL	Queen's University Canada	NAPCCB
6	C. STADLER Dr. M. WICKE	Universität Innsbruck Austria	RAHM
7	Prof. J. EIBL I. RETZEPIS J. HUANG	Universtät Karlshure (TH) Germany	DLTPC ABAQUS
8	Prof. Zivota PERISIC Nebojsa OJDROVIC	University of Belgrade	ConcreteMac
9	Prof. Dr.-Ing. György IVANYI W. BUSCHMEYER Y. HU	Universität Essen Germany	VOV
10	Jan L. VITEK Petr VITEK	Czech Technical University of Prague Czech Republic	VOK-2
11	Antoine E. NAAMAN Sang-Mo JEONG	University of Michigan U.S.A.	
12	GARCIA MENEZES FOURE	CEBTP France	SNOB
13	Prof. Filip C. PHILIPPOU	University of California U.S.A.	PCBEAM
14	Dr. Mineo MORIMOTO Mitsuharu KOMURO	New Structural Engineering Japan	

COMPARISON OF THE RESULTS

The calculation results are compared in this part with general load/deflection curves.

Twelve cases are distinguished :

- one-span beam and continuous beam ;
- cast-in-place beam and precast beam ;
- 100 % external prestressing, 50 % external / 50 % internal prestressing, and 100 % internal prestressing.

For the concrete characteristics, there were two options : with tensile strenght, or not. We preferably give the load/deflection curve in the case with tensile strenght, when the choice is possible.

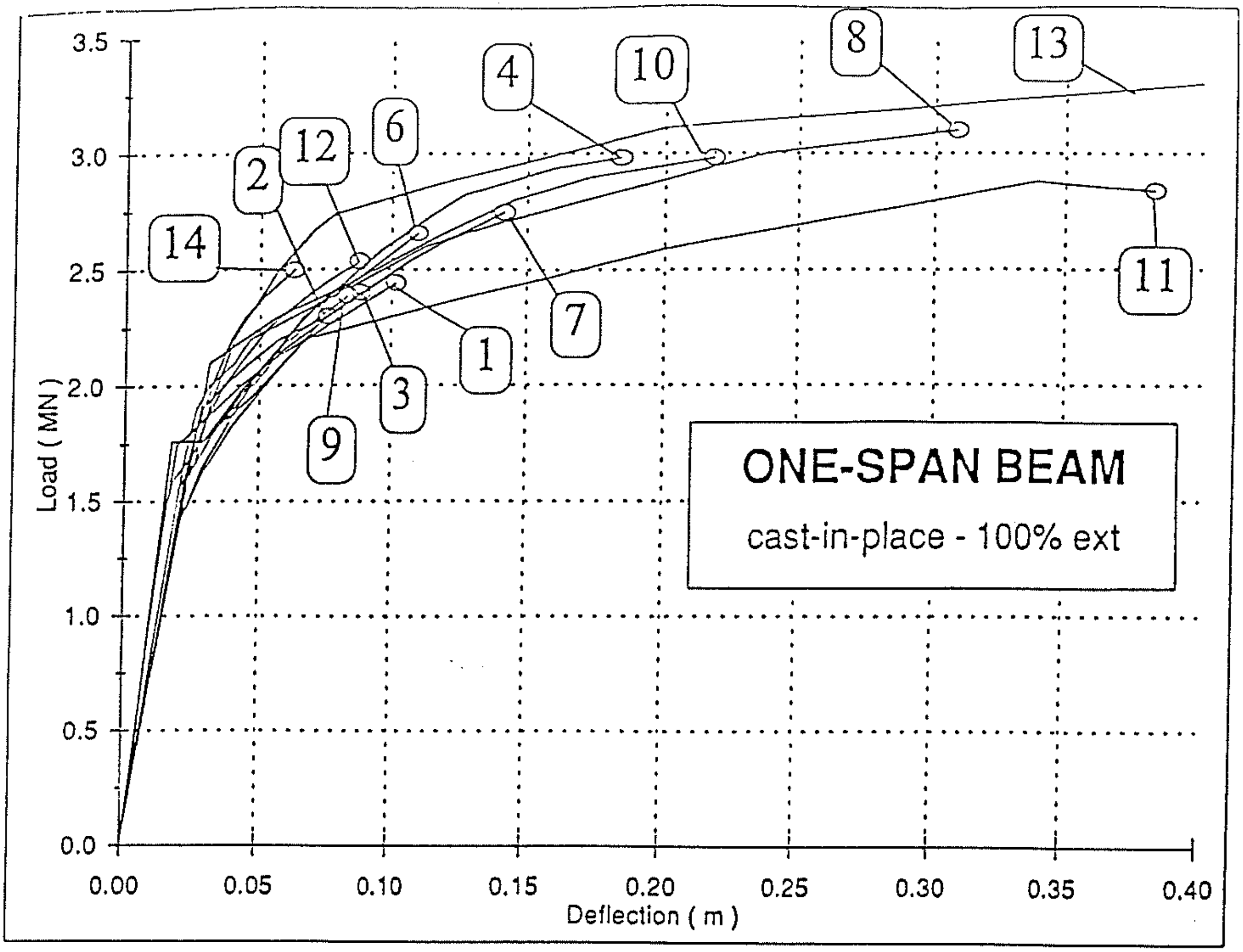
For the behaviour of the tendons, there were two options : with free slip at deviators, or with no slip. We preferably give the curve in the case with no slip, because we have more answers for it.

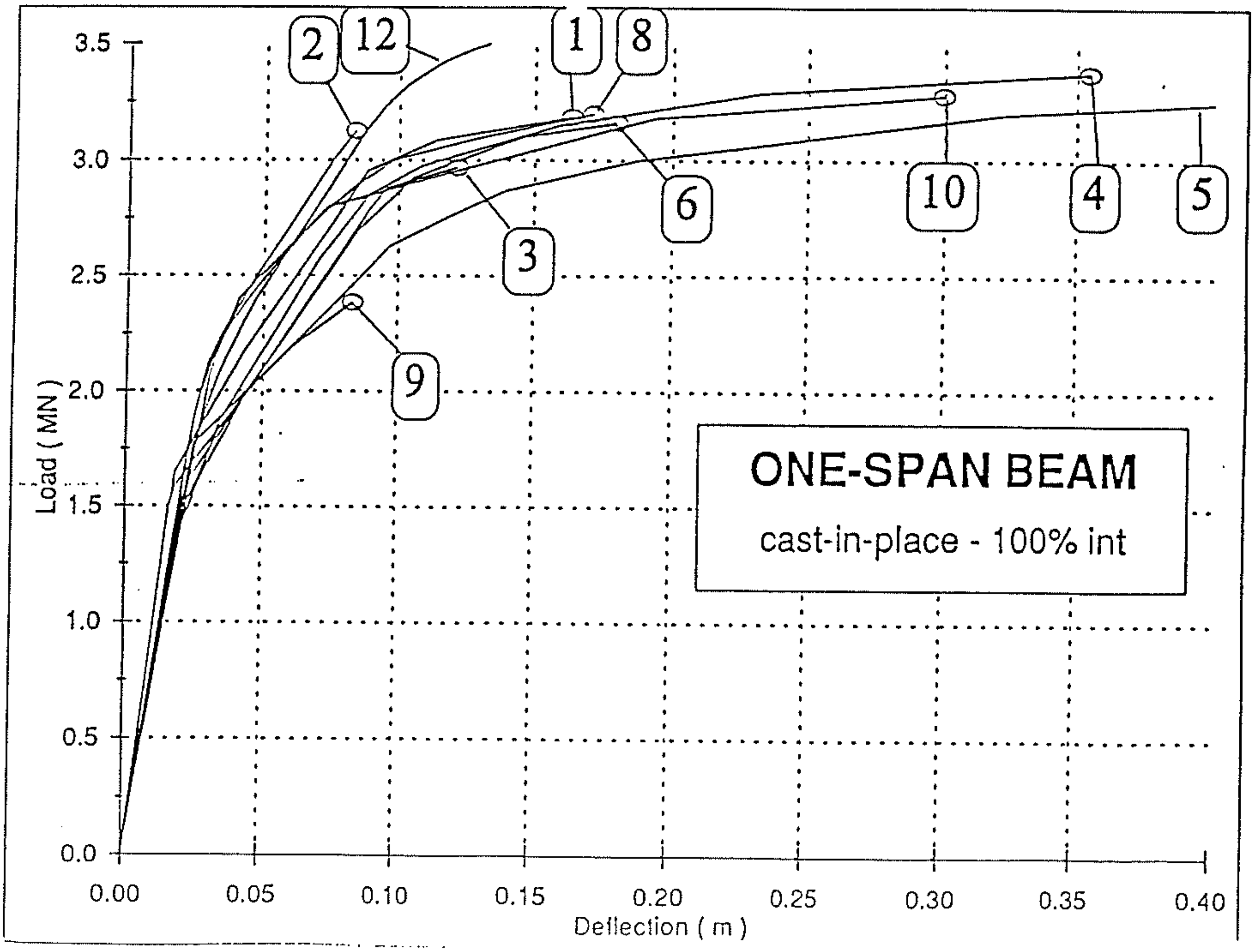
The received results are recapitulated in the following table.

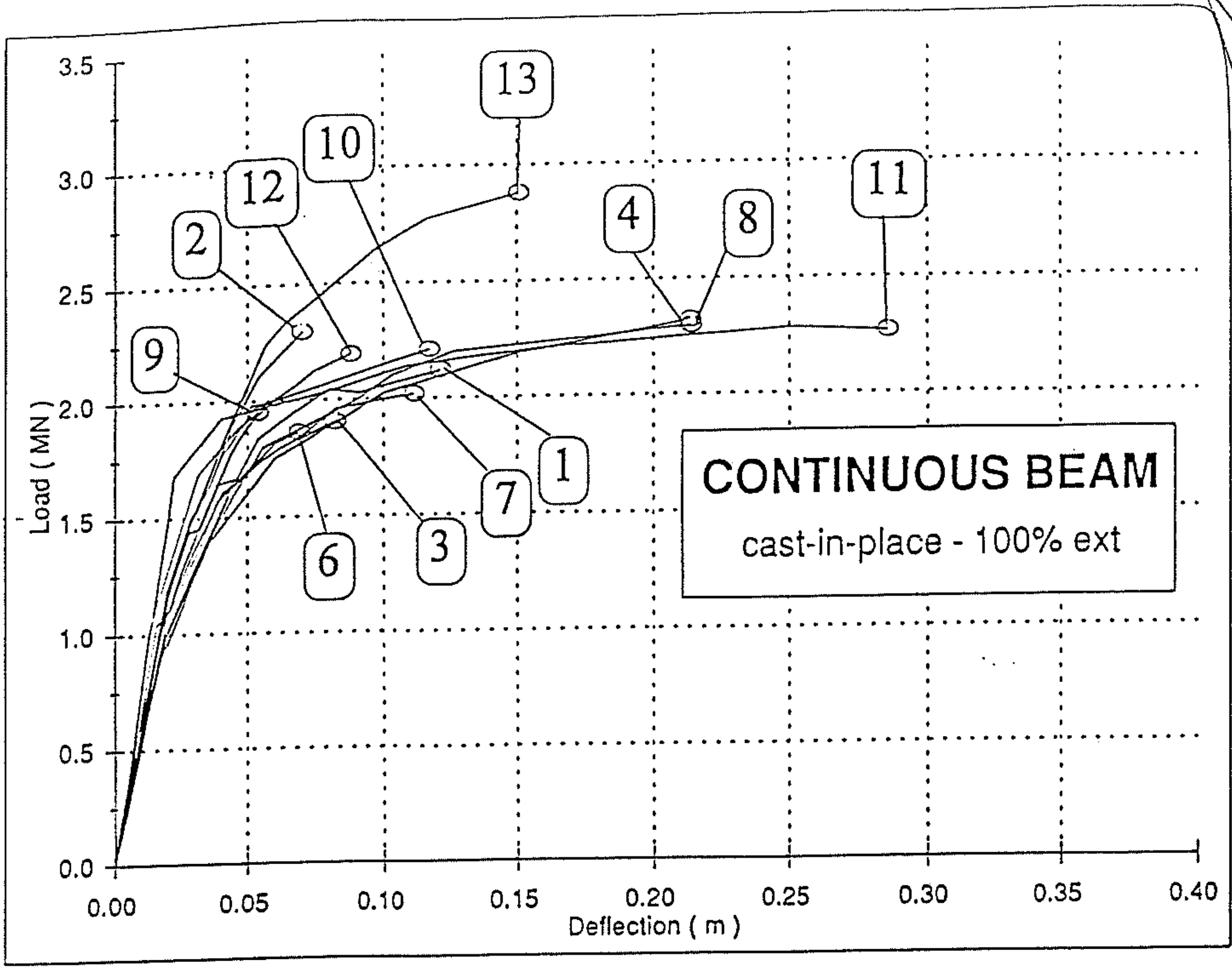
	ONE-SPAN BEAM						CONTINUOUS BEAM					
	cast-in-place			precast			cast-in-place			precast		
	100% ext.	50% 50%	100% int.	100% ext.	50% 50%	100% int.	100% ext.	50% 50%	100% int.	100% ext.	50% 50%	100% int.
1	X	X	X				X	X	X			
2	X		X				X		X			
3	X		X				X		X			
4	X*		X*				X*					
5			X						X			
6	X	X	X				X	X	X			
7	X			X			X			X		
8	X	X	X	X*		X*	X	X	X			
9	X	X	X	X*	X*	X*	X	X	X	X*	X*	X*
10	X	X	X	X	X	X	X	X	X	X	X	X
11	X*						X*					
12	X		X				X		X			
13	X						X					
14	X											

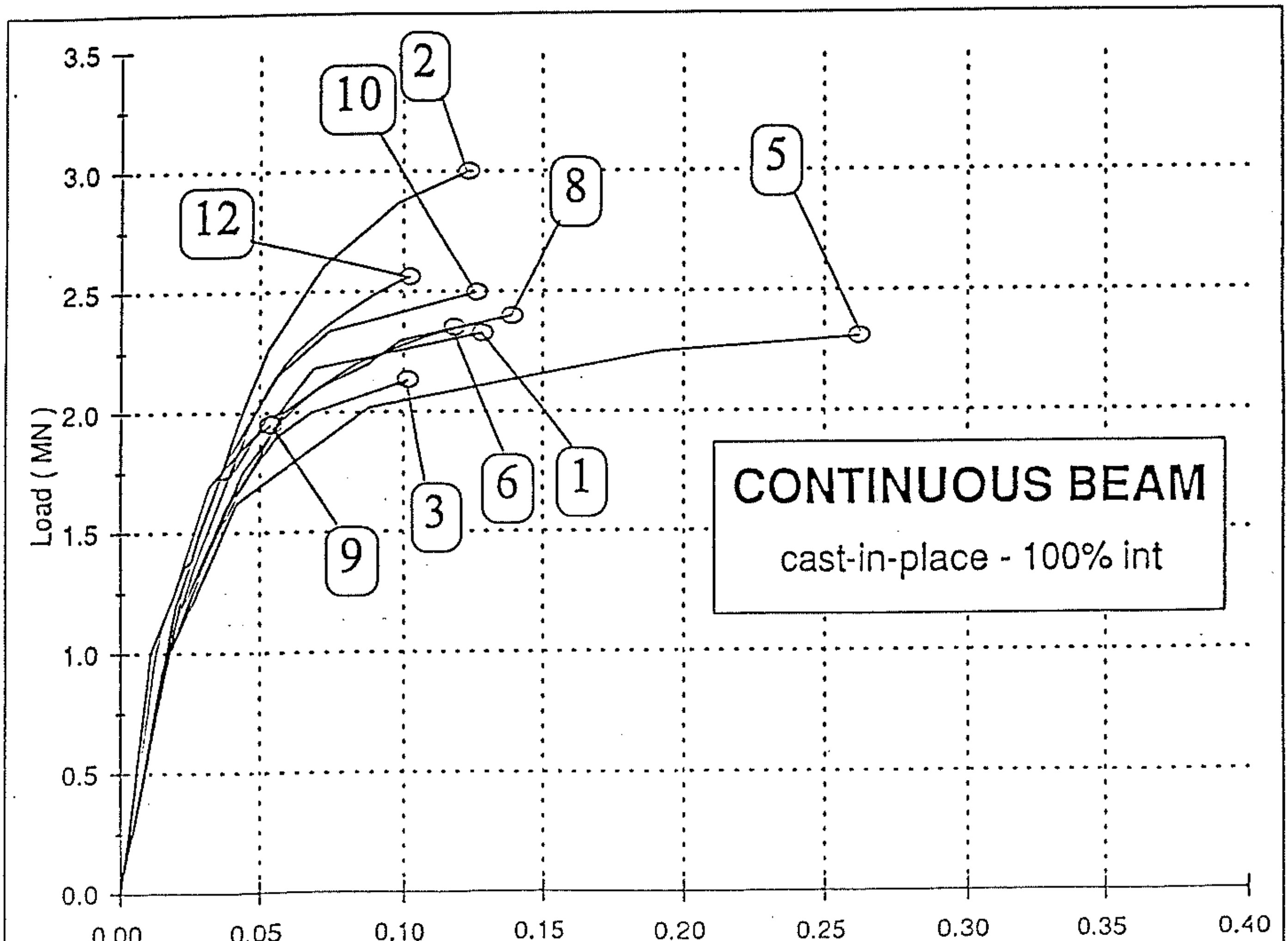
* : no concrete strength in tension

⅄ : full slip at deviators


ONE-SPAN BEAM
cast-in-place - 100% ext
Load (MN)
Deflection (m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1
2
3
4
6
7
8
9
10
11
12
13
14


ONE-SPAN BEAM
cast-in-place - 100% int
Load (MN)
Deflection (m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1
2
3
4
5
6
8
9
10
12


CONTINUOUS BEAM
cast-in-place - 100% ext
Load (MN)
Deflection (m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
13
10
12
2
9
4
8
11
1
7
3
6


CONTINUOUS BEAM
cast-in-place - 100% int
Load (MN)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
2
10
12
8
5
9
3
6
1