

CAD SYSTEM (COMPUTER AIDED DESIGN) FOR THE PLANNING OF
THE TERRITORY, WITH REFERENCE TO THE AUTOMATICAL
ESTIMATE OF WORKS OF URBANIZATION

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1. INTRODUZIONE

Any applied research, no matter what discipline is concerned, needs affined and suitable tools; as regards the studies in the field of architecture and planning, the use of automatic systems of analysis, data ordering and comparison is of particular interest. The quickness of operations by means of computers and the corresponding graphical representation gives new possibilities for scientific work, once impossible, not certainly because of conceptual limits, but practically, for the limits of available tools.

It is the wideness of applications of computers to be pointed out, for although studied for scientific reasons, their practical usefulness is often enormous. This has been generally verified. It guilts in particular for the CAD System, proposed and explained in this paper. The practical utility this and other systems from the same field have for the public administration, contractors and consultants is well known and therefore not necessary to be described further.

The use of such systems is particularly convenient in those sectors where the graphical representation is the basic part of the production process.

2.- THE SCOPE OF THE RESEARCH

In order to respond to the requirements mentioned above, a decision was made to study the CAD integrated

system for the territorial planning and particularly in order to obtain an automatized estimate as regards urban works.

A bidimensional CAD Programme was connected with the procedure of estimating the public works; it was then implemented to a hardware which, although remaining within the typology of the personal computer, allowed outputs on a sheet of paper of noticeable sizes (1.60 or 3.20 m at a continuous length).

This procedure allows to obtain automatically the measures of the object considered, to get it memorized, graphically represented and estimated.

The advantages of the system are:

- an easy input of data directly from the graphic with the digitizer's pick-device;
- the automatical calculation of measures which, especially in the case of an estimate of areas and volumes, results generally from a rather complex mathematical functions particularly in calculations of excavations or fillings of road sections;
- the precision of survey which is in an automatic procedure equal to 0.1 mm (the precision of the digitizer), and in a manual procedure is equal to 0.5 mm (the eye of the surveyor is able to estimate at the rate of 0.5 mm, which is equal to the graphical precision of common drawings);
- the reduction of casual and systematic errors, since various sizes are described and estimated in a single operation.

The described operations can be carried out with a speed from about six to ten times superior to the common one.

The use of the system does not require any special technical preparation. Generally, a week of training is sufficient to obtain a complete operational ability.

3.- METHODOLOGY

The study consists of three phases:

- A.- the individualisation of the hardware elements of which the CAD cell is composed;
- B.- the creation of the software for the management of a

bidimensional CAD procedure;

C.- the creation of the software for the management of the procedure for the estimate of public works.

In the first phase the hardware support was defined. It consists of:

- a computer;
- 2 displays, for text and graphics, being the latter monochromatic, 512 x 512 pixel;
- a disc unit, 2 Mbytes;
- a digitizing tablet, 1.20 x 2.20 m, with a graphical precision of 0.1 mm (see fig. 1);
- a plotter with a graphical output on paper of max. height 1.60 m and continuous length (there is a plotter in the phase of assemblage of which the max. height is 3.20 m.), the speed of writing being 400 mm/sec., and the graphical precision 0.1 mm.

In the second phase regarding the creation of the software for the management of the CAD procedure, it was proceeded in the following way:

The series of typical CAD commands were defined, like the description of segments, broken lines, moduli, polygons, areas, volumes, road sections, texts, altitudes etc.

The variables X and Y (corresponding to the coordinates), constants K (scale and setting factors) and vectors (corresponding to the orientated segment connecting two points) were associated.

In fact, the interface works through a series of elementary operations using these three components.

The constant K can be introduced through the keyboard or calculated geometrically; a series of functional operations can be carried out on this basis.

The "vector X" can be handled through the "support vector A" which depends on the "vector X" through the constant K:

$$A_0 = K \quad A_1 = K \quad \dots \quad A_N = K, \quad A_0 = 0 + K \quad A_1 = 1 + K \quad \dots \quad A_N = N + K,$$

...

This artifice allows to record contemporaneously various movements on the screen and within the data structure, both through the movements of the digitizer's pick-device and mathematical procedures.

The movement of cursor produces an echo of the displacement, allowing to describe the objects on the screen and to memorize them contemporaneously in the data

structure of the programme.

The graphical descriptions are further followed by a series of accessory commands, allowing to choose the type and the colour of the pen, the type of representation, the type of characters, quotings, positioning, translation, rotation etc.

The description obtained is detailed and complete, corresponding to the common architectural drawings.

In the third phase in which the software is created for an estimate of public works, files of codes and calculation procedures are built up.

If the option "estimate" is chosen from the menu, a codification will be associated to the common procedure of graphical survey with digitizer (described in the second phase).

The objects (broken lines, polygons, areas, volumes) will assume a particular significance within the data structure, that is, not only as graphical descriptions or geometrical evaluations (lengths, surfaces, volumes) but as corresponding to the particular type of material or a productive operation and also to the unit price associated by means of a code.

Once put in work the function "estimate", the computer is ready for graphical acquisition and is contemporaneously able to carry out a complete estimate on the basis of the surveyed geometrical elements and displayed on the graphics screen.

The operator will not have to do any numerical survey, nor to calculate, nor to report the results on the various elaborates of calculations, it will continue to handle the information graphically, with all advantages.

The data which have been introduced automatically through the CAD procedure into the programme of estimate of public works will be worked out in all its computational parts, from the documentation of the production costs, that is, the cost analysis, to the total or partial metrical estimate; from the detailed estimate of operations within the economical framework, to the supplementary estimate or to the estimate of variants; from the contract including the beginning and the end of the works, up to the measures registers.

The revision of costs which allows to determine an eventual supplementary compensation is included into

the possibilities of operations.

4.- THE ANALYSIS OF THE RESULTS

In order to utilize the integrated CAD procedure the operator will have to proceed in the following way:

- to supply himself with the plan of the area in a suitable scale, in order to get a graphic on the basis of which the estimate can be made;
- to position it on the digitized tablet and proceed with a graphical survey, in overlapping the magnetical pick-device and various points to be obtained;
- to choose within the menu options those which are of interest (see fig. 2);
- to introduce the scale of setting (angular and of X and Y axes) for various positions of paper.

On the graphics display the drawing of the survey will be displayed (see fig. 3), and on the other one the numerical data and menu operations will be handled. This way will allow a continuous control of the survey.

The possibility of magnifying the drawing on the screen, through the windows and zooms, will allow to obtain major precision even when the drawing is large.

With the CAD procedures which have been described, the user will be able to describe, for example a canalisation network, a plant, an excavation, a surface to pave, a volume of concrete for a supporting wall etc.

The drawings showing various applications of the system are enclosed:

- an area of Moggio Udinese (UD), completely memorized and of which particular buildings have been made evident;
- an automatically obtained graphic of the surface to be paved in porphyry (see fig. 5), consisting of the plotted drawing and the data sheet of the estimate;
- transverse and longitudinal sections of the road (see fig. 6), followed by the usual calculations and by the estimate of the excavations and fillings.

The complexity of mathematical functions described by the drawings is evident and the visual communication between the operator and computer is more refined and interesting than the numerical one.

5.- CONCLUSIONS

This system allows to adapt the described programme to respond various requirements. Its general validity and interest lies therefore in its versatility.

The memory of a certain number of data and their graphical representation allows to prepare, for example, out of original maps, the "thematical maps" containing series of preliminary data to be displayed graphically.

These data, correlated with numerical functions or constants, can supply elements of design, control and estimate.

The same elements, with an extension of the described programme, can be easily optimized for searching the best possible solutions on the basis of the predisposed criteria.

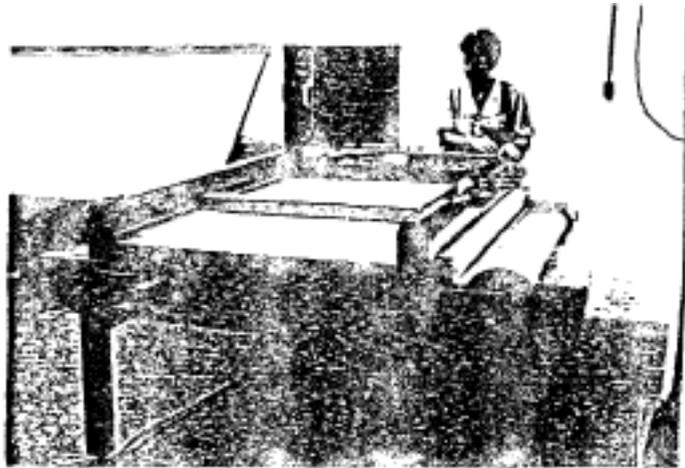
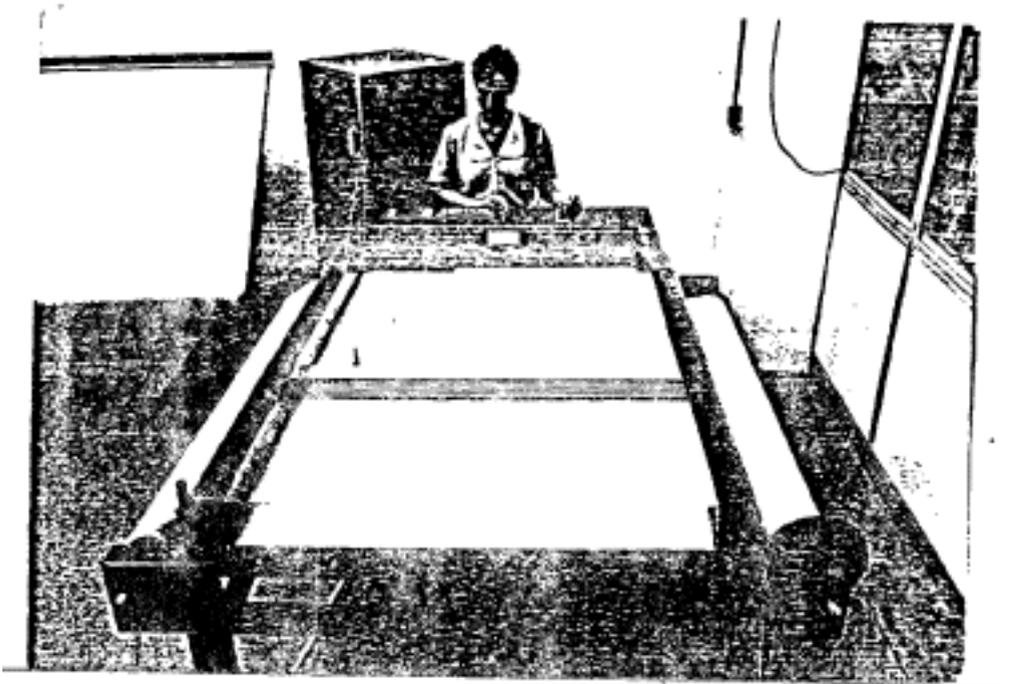


Fig. 1

SIN	ICOS	ITAN	ITATH	IEXP	ILOG	IABS	IINT
SWAP K,I	ISWAP K,M	ISWAP X,A	ISOMMA A	ISOMMA X	IREDUCE A	IREDUCE X	IRA = A * X
CLEAR M.	ISOMMA M.	IRICHA.M.	IRE/POL X1	IRE/POL X2	IRAD/GRAD	IRAD/GRAD	ISIZE X
SIZE Y	ORIENTAM.	INCLINAZ.	IDRAW TEXT	IDRAW A	IDRAW X	ICIRCLE X	IRADIUS X
A0 = K	IA1 = K	IA2 = K	IA3 = K	IA0=AR0+K	IA1=R1+K	IA2=R2+K	IA3=R3+K
CLEAR X	ICLEAR A		IVEL.PLOT.		ITAR.VIDEDITAR.PLOT.	ITAR.DIG.	
COORD. X	ICORD. Y	IX,Y DA D.	ISCALA X	ISCALA Y	IFATT.SCA.	IANGOLO	
PENNA 1	PENNA 2	PENNA 3	PENNA 4	PENNA 5	PENNA 6	PENNA 7	PENNA 8
PENNA 9	PENNA 10	PENNA 11	PENNA 12	PENNA 13	PENNA 14	PENNA 15	PENNA 16
HARDCOPY	ICLEAR	ICL.SCREEN	IAQUISIZ.	ILINETYPE	IPENNA	IVEDI CUR.	IRASC.CUR.
IN.SPEZZ.	IDIST.TRA.	IRANG.TRAT.	IRIN.TRATT.	DIM.TESTO	IRANG.TESTO	IPOS.TESTO	ISTRINGA
CORSIVO	IN.TESTO	IDIM.QUOTA	ICALC.RUT.	TIPO QUO.	ITN.QUOTA.	IIN.SEZIO.	IFINE SEZ.
IN.STRAD	IFINE STR.	IRASSE STR.	IRIN.TERRE.	IRINIZ.SUP.	IRANG.IN/FI	IRAGGI X/Y	IRARCO
PRECISIO.							
COO.PART.	IMEM.PART.	IRIC.PART.	IRINOME DIS.	IRMEM.DISE.	IRICH.DIS.	IRSECO.VID.	IRES.PLOTT.
CANC.ATT.	ICAN.PREC.	ICANC.OGG.			ICONFERMA	IRNON CONF.	IFINE RIC.
ANGO. INF.	IRANGO.SUP.	IFIN.VIDEDITAR.PLOT.			IZOOM	IRITORNA	IRIT.INIZ.
COMPUTO	IRICERCA	IFINE COM.			IPEN./DIM.	IRQUOT.OGG.	IPREC.SEZ.
COP.DISCO	ICANC.DIS.	IRIRECTORY	IRILE.PART.		IRIGLIA	IRVEDI QUO.	IFINE LAV.

Fig. 2

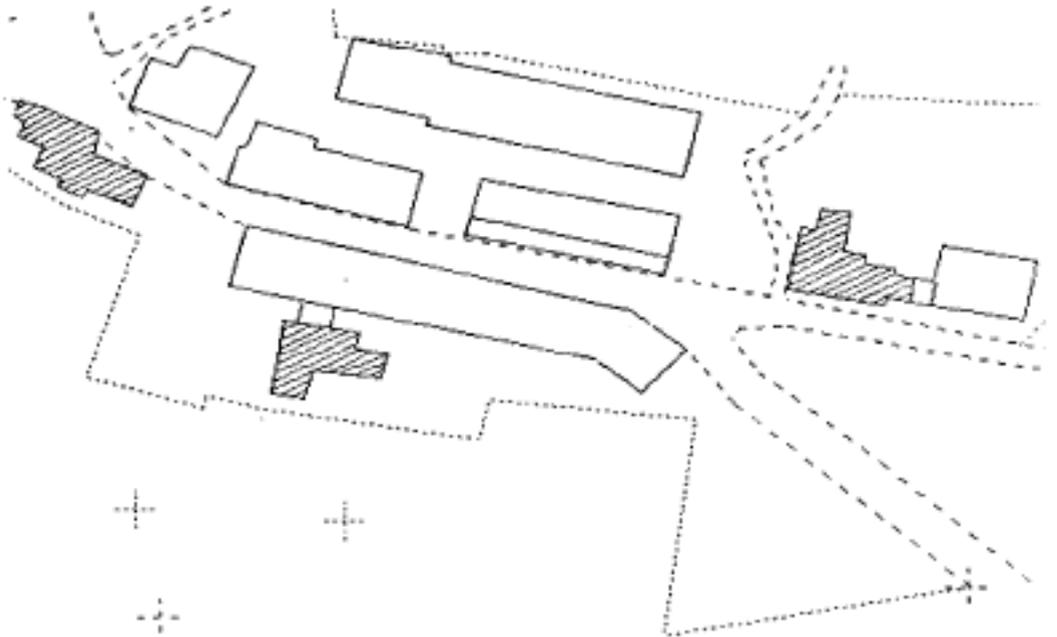


Fig. 3

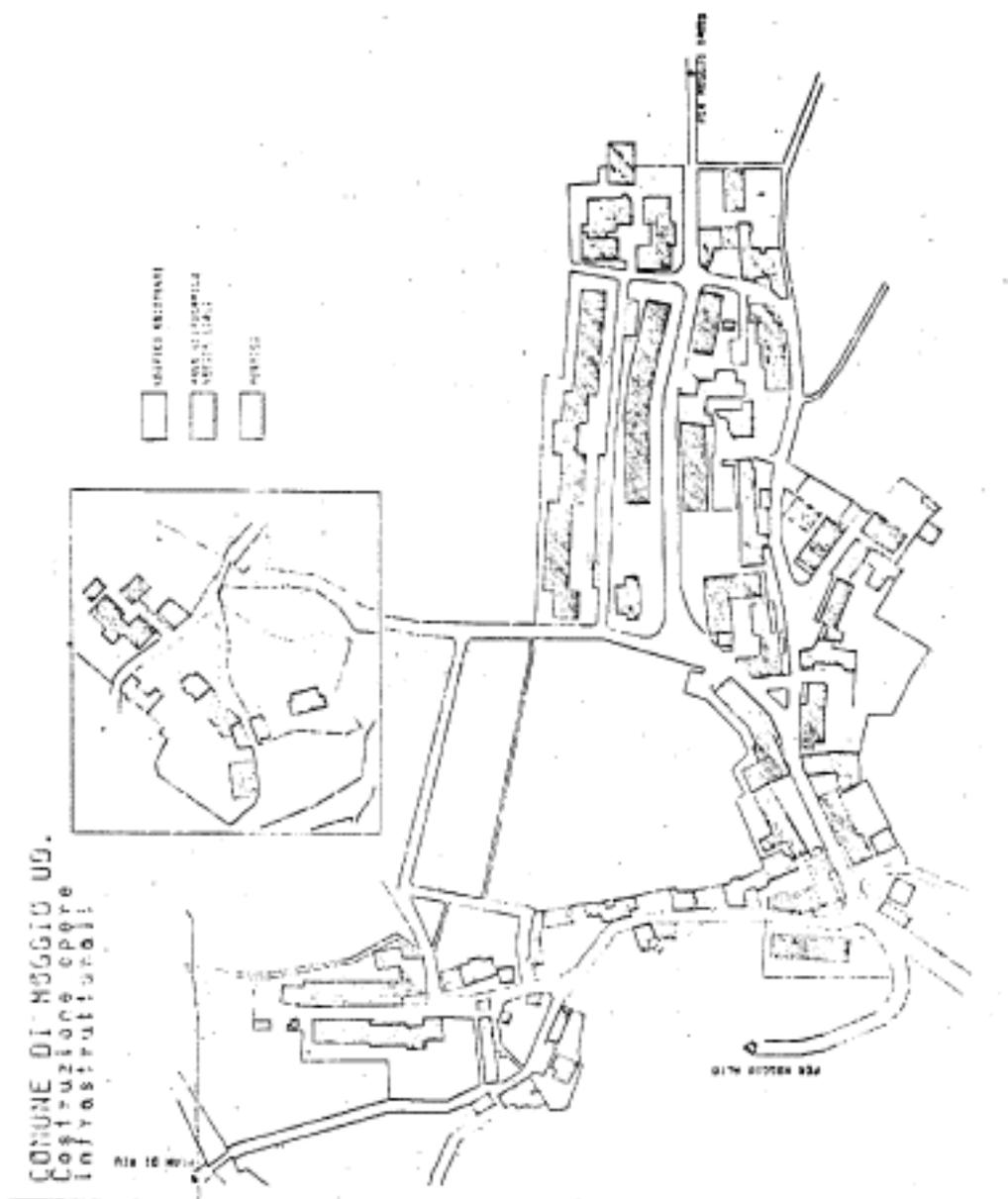


Fig. 4

PRVIMENTRZIONE IN PORFIDO
TRATTO 14

COMUNE DI MOGGIO UD.

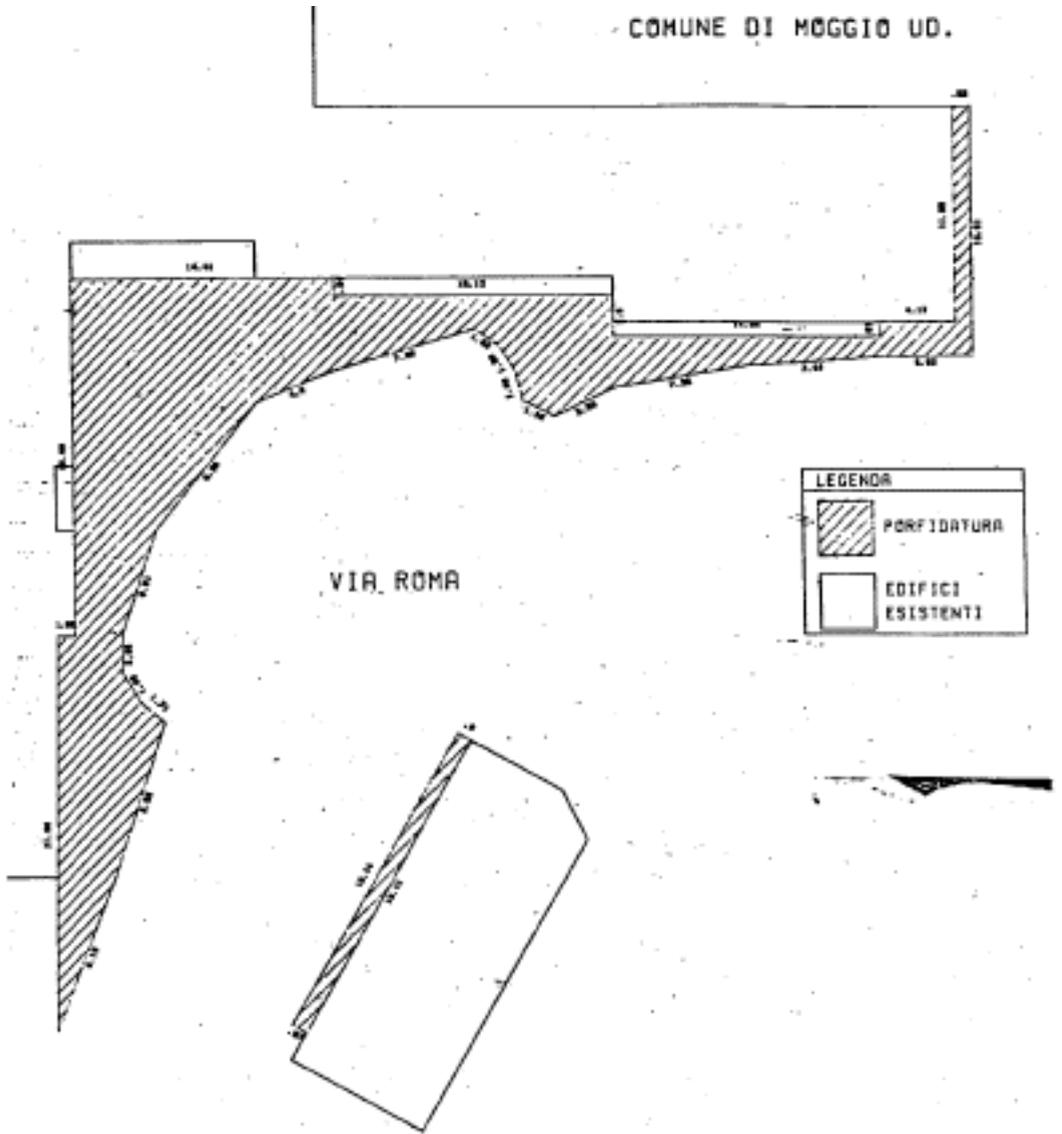


Fig. 5

NORD	NEP	DESCRIZIONE	CUM	ATTR	PARZIALE	TOTALE
18	9	Splateamento con scavo della coltura e estirpamento piante di qualsiasi specie e dimensione e loro relative ceppaie con carico e trasporto a qualsiasi distanza				
		(21,860+00000)*0,020/2	3	mq	0,218	
		(21,860+21,860)*1,000/2	3	mq	23,698	
		(41,550+21,860)*0,020/2	3	mq	0,634	
		(41,560+41,560)*14,410/2	3	mq	598,887	
		(40,520+41,560)*-0,010/2	3	mq	-0,410	
		(40,480+40,520)*15,120/2	3	mq	612,360	
		(38,180+40,480)*-0,020/2	3	mq	-0,786	
		(38,120+38,180)*14,560/2	3	mq	556,227	
		(38,950+38,120)*-0,010/2	3	mq	-0,385	
		(38,930+38,950)*4,120/2	3	mq	160,432	
		(50,940+50,920)*0,930/2	3	mq	47,364	
		(37,030+50,940)*-0,020/2	3	mq	-0,679	
		(36,980+37,030)*-5,030/2	3	mq	-186,135	
		(36,500+36,980)*-7,420/2	3	mq	-272,610	
		(35,380+36,500)*-7,160/2	3	mq	-257,044	
		(33,740+35,380)*-3,220/2	3	mq	-111,154	
		(34,600+33,740)*-1,720/2	3	mq	-58,772	
		(36,400+34,600)*-0,460/2	3	mq	-16,330	
		(37,740+36,400)*-0,660/2	3	mq	-31,880	
		(38,630+37,740)*-1,240/2	3	mq	-47,349	
		(36,350+38,630)*-7,630/2	3	mq	-286,048	
		(34,600+36,350)*-4,250/2	3	mq	-156,769	
		(27,680+34,600)*-5,590/2	3	mq	-173,849	
		(21,900+27,680)*-1,920/2	3	mq	-47,520	
		(19,850+21,900)*-0,010/2	3	mq	-0,208	
		(18,120+19,850)*0,990/2	3	mq	18,795	
		(16,990+18,120)*1,290/2	3	mq	22,645	
		(8,560+16,990)*-2,680/2	3	mq	-34,237	
		(0,860+8,560)*-3,290/2	3	mq	-14,179	350,547
20	9	Splateamento con scavo della coltura e estirpamento piante di qualsiasi specie e dimensione e loro relative ceppaie con carico e trasporto a qualsiasi distanza				
		(16,470+0,420)*9,070/2	3	mq	76,596	
		(16,060+16,470)*0,690/2	3	mq	11,222	
		(00000+16,060)*-9,800/2	3	mq	-72,270	
		(0,420+00000)*-0,740/2	3	mq	-0,155	15,393

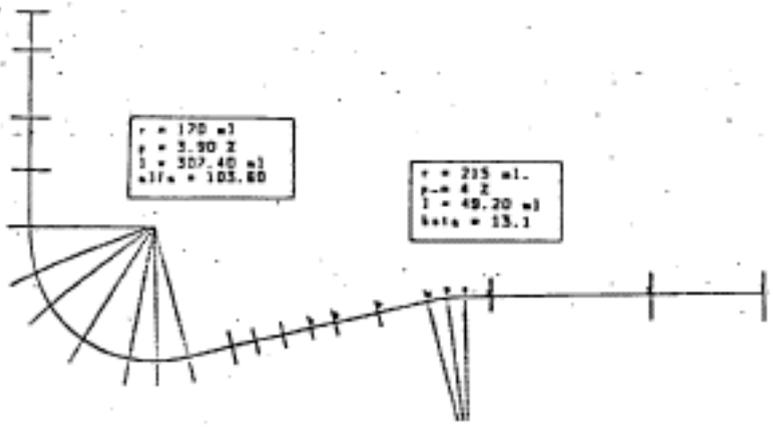
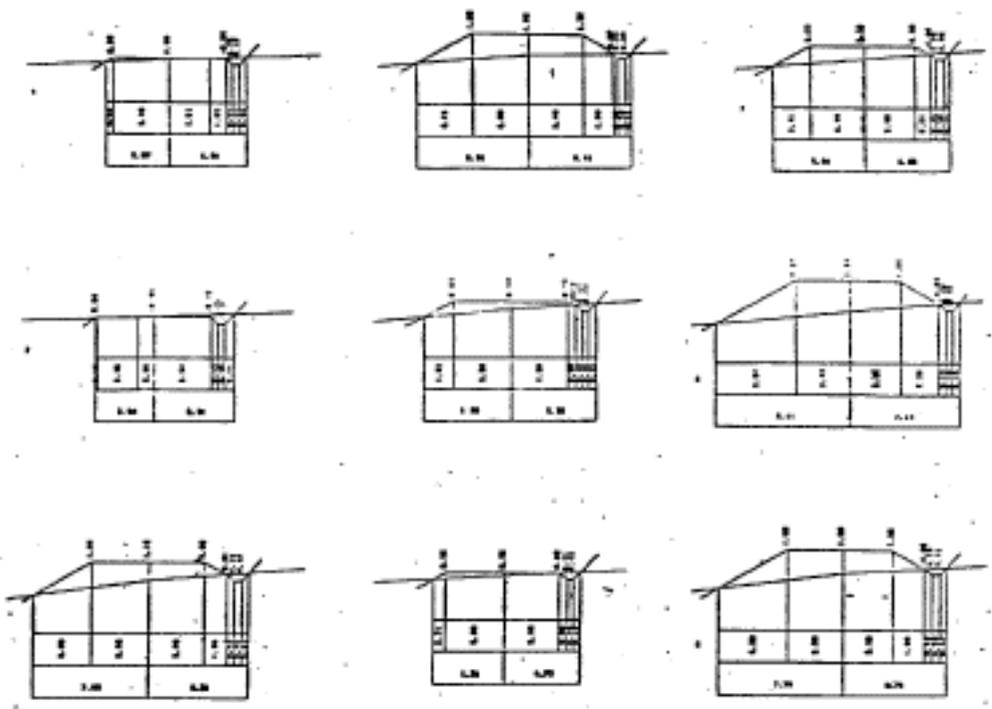


Fig. 6

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